AD-A200 665 REMOTELY PILOTED VEHICLE (RPV) TWO VERSUS THREE LEVEL MAINTENANCE SUPPORT CONCEPT STUDY(U) ARMY MISSILE COMMAND REDSTONE ARSENAL AL J H NORDMAN ET AL. 15 JAN 88 AMSMI/LC-TA-88-01 1/1

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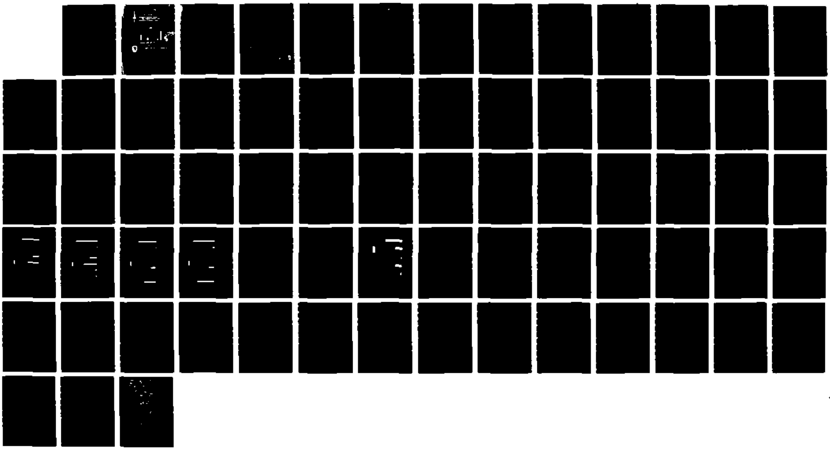

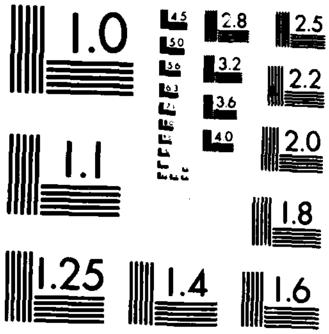

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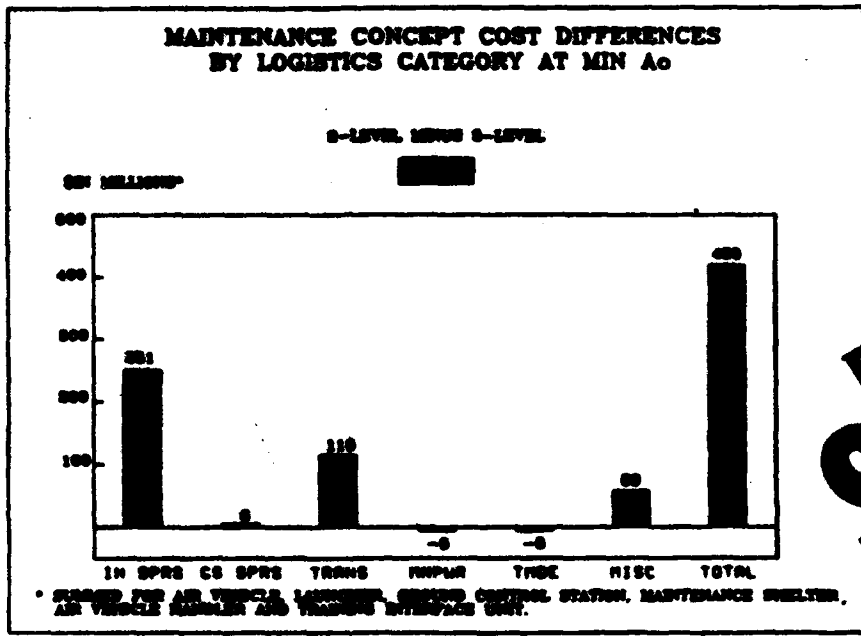
REMOTELY PILOTED VEHICLE (RPV) TWO VERSUS THREE LEVEL MAINTENANCE SUPPORT CONCEPT STUDY



15 JANUARY 1988

U.S. ARMY MISSILE COMMAND

Redstone Arsenal, Alabama 35898-5000

PREPARED BY

1) TECHNICAL ANALYSIS & SUPPORT OFFICE, MLC

2) SYSTEM ANALYSIS DIVISION, SA&EO

3) ADVANCED SYSTEMS CONCEPT OFFICE, RD&E CENTER

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(1)

REMOTELY PILOTED VEHICLE

TWO VERSUS THREE LEVEL

MAINTENANCE SUPPORT CONCEPT STUDY

15 JANUARY 88

PREPARED BY:

JOSEPH H. NORDMAN
OPERATIONS RESEARCH ANALYST
SYSTEM ANALYSIS DIVISION
SYSTEM ANALYSIS & EVALUATION OFFICE

WAYNE M. LEONARD, JR.
GENERAL ENGINEER
FIRE SUPPORT TEAM
ADVANCE SYSTEM CONCEPT OFFICE

ADRIAN A. ABRAMS
OPERATIONS RESEARCH ANALYST
TECHNICAL ANALYSIS & SUPPORT OFFICE
MISSILE LOGISTICS CENTER

APPROVED BY:

HENRY M. FAIL
CHIEF
TECHNICAL ANALYSIS & SUPPORT OFFICE
MISSILE LOGISTICS CENTER

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AD-A200 665

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188
Exp. Date: Jun 30, 1986

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION MLC SA&EO RD&E Center — 6b. OFFICE SYMBOL AMSMI-LC-TA AMSMI-OR-SA AMSMI-RD-AC	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Commander U.S. Army Missile Command ATTN: AMSMI-LC-TA, Redstone Arsenal, AL 35898-5230	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION — 8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. — PROJECT NO — TASK NO — WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)
Remotely Piloted Vehicle Two Versus Three Level Maintenance Support Concept Study

12. PERSONAL AUTHOR(S)
Joseph H. Nordman, Wayne M. Leonard, Jr., and Adrian A. Abrams

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM ______ TO ______	88 Jan 15	56

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Logistic Cost
Supply & Maintenance Cost
Maintenance Support Concepts
SESAME Model, OSAMM Model

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

See page vii of this report

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
☒ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION

22a. NAME OF RESPONSIBLE INDIVIDUAL — 22b. TELEPHONE (Include Area Code) — 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

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RPV Two Versus Three Level

Maintenance Support Concept Study Team

Adrian A. Abrams	MLC, Technical Analysis & Support Office
Donnie Joyce Allen	Advanced Systems Concepts Office, Secretary
Robert Baker	RPV Project Office (Chairman)
Jeanette Dean	MLC, Maintenance Engineering Directorate
Jim Gebhart	MLC, Technical Analysis & Support Office
Wayne Henderson	MLC, Maintenance Engineering Directorate
Cecil Hudson	MLC, Maintenance Engineering Directorate
Wayne Leonard	Advanced Systems Concepts Office
Sharon Menefee	MLC, Maintenance Engineering Directorate
Lester G. Mitchell	MLC, Maintenance Engineering Directorate
Ed Moore	RPV Project Office (Alternate Chairman)
Joe Nordman	Systems Analysis and Evaluation Office
Lamar Sloan	MLC, Maintenance Engineering Directorate
Dan Smith	MLC, Maintenance Engineering Directorate
Joel Strickland	MLC, Technical Analysis & Support Office
August Tranquill	MLC, Technical Analysis & Support Office
Steve Weber	MLC, Maintenance Engineering Directorate

ACKNOWLEDGEMENTS

The authors of this report would especially like to thank Mrs. Wanda L. Lavender, Mr. John Starnes and Mrs. Donnie Allen from the U.S. Army Missile Command, Mr. Mike Gomez, Lockheed Missiles and Space Company Inc. at Austin, Texas, Mr. Alan Kaplan, US Army Materiel Systems Analysis Activity - Inventory Research Office (AMSAA-IRO) and Dr. Charles Plumeri, U.S. Army Communications and Electronics Command (CECOM) for their valuable efforts/assistance. A System Analysis team concept was employed throughout this study in which several organizational disciplines were molded together into an effective group.

ABSTRACT

This study addresses selected Remotely Piloted Vehicle (RPV) subsystems lifetime supply and maintenance (S&M) costs for two maintenance support concepts. The first concept consists of two levels of support, organizational and depot; and the second concept consists of three levels of support, organizational, intermediate (direct support and general support) and depot.

Lifetime costs applicable to current peacetime conditions are estimated. This is accomplished through the methodology of the Optimum Supply and Maintenance Model (OSAMM) which uses AMC-approved supply model, called Selected Essential-Item Stockage for Availability Method (SESAME), model as a subroutine. The unique features of OSAMM allows it to simultaneously minimize costs, develop maintenance task distributions, and quantities and placement of test equipment and stockage while achieving a pre-stated operational availability target. Results are presented over a range of operational availability values of interest in which supply quantities are variants.

The salient conclusion of this study is that the Three Level Support Concept is less expensive than the Two Level Concept for every selected subsystem studied except one - that one exception has a small cost impact. Justification for this conclusion is discussed in relationship to individual logistic cost categories. Also, another very interesting "side" conclusion is reached for the Three Level Concept: that is, the operational availability can be significantly improved with small stockage cost increases. The logic behind this surprising condition will be obvious.

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1.0 PURPOSE/OBJECTIVE. The single objective of this study is to compare selected RPV subsystem lifetime supply and maintenance (S&M) costs for two and three level support concepts in order to determine the least costly approach. The support concepts consists of the following echelons:

a. Two Level - Organizational (ORG) and Depot

b. Three Level - Organizational, Intermediate-Direct Support (DS) and General Support (GS), and Depot.

1.1 Two parallel studies were conducted. One study is by the US Army Missile Command (MICOM) RPV Maintenance Concept Study Team consisting of members listed earlier in this report. The other study was conducted by the The Analytical Science Corporation (TASC), Reading, Massachusetts which supports MICOM's results.

2.0 BACKGROUND. The Remotely Piloted Vehicle Project Office (AMCPM-RP) was tasked by Headquarters, Army Materiel Command (HQ AMC) to determine if two levels of maintenance support are less costly than three levels for the prime equipment of the RPV system. In response, the RPV Maintenance Concepts Study Team was formed. The team suggested seven RPV subsystems for consideration. These subsystems, which are listed in Table 1, contain the bulk of the Line Replaceable Units (LRUs) or components of interest. The remaining subsystems are not included for one of the following reasons:*

a. The subsystem is managed by another command.

b. A maintenance support policy already exists for the subsystem.

TABLE 1. RPV Subsystems Analyzed

AIR VEHICLE
LAUNCHER
RECOVERY
GROUND CONTROL STATION
MAINTENANCE SHELTER
AIR VEHICLE HANDLER
TRAINING INTERFACE UNIT

The following paragraphs depict the viewpoints and chronologically the events leading to the development of this report.

***Source: Conversations with representatives from AMCPM-RP, March 1986.**

2.1 Initially, in June 1986, the RPV Project Office requested the Missile Logistics Center (MLC) to perform a Two versus Three Level Maintenance Concept Study. In response to this request, a meeting was held in August 1986, chaired by RPV Project Office with representatives from Technical Analysis and Support Office (AMSMI LC-TA), Systems Analysis and Evaluation Office (AMSMI-OR SA), and Maintenance Engineering Directorate (AMSMI-LC-ME). At this meeting, the following was accomplished:

a. RPV Project Office agreed to the following:

(1) Provide and/or coordinate the acquisition of contractor furnished inputed data.

(2) Deliver a description of the study goals, constraints, pertinent assumptions and outputs expected from the study.

(3) Provide funding for computer associated activities.

b. The Technical Analysis and Support Office agreed to accept primary responsibility for performing the study.

c. Systems Analysis and Evaluation Office agreed to provide consultative assistance and participate in performing the study.

d. The Maintenance Engineering Directorate agreed to provide assistance where needed in their area of expertise.

e. Two logistics cost models were nominated as possible candidates for use in performing the study. These models are the Optimum Supply and Maintenance Model (OSAMM)[1] and the Logistics Analysis Model (LOGAM)[2].

2.2 Data to run both OSAMM and LOGAM models were collected from September 1986 through December 1986. The Systems Analysis and Evaluation Office provided consultative assistance regarding the required inputs and data definitions. The prime contractor, Lockheed Missiles and Space Company, Inc., Austin, Texas provided the bulk of the system specific inputs, while Government sources (RPV Project Office, MLC, and Comptroller, MICOM) provided generic inputs.

2.2.1 During the September - December 1986 time period, a decision was reached to use the OSAMM model. The reasons supporting this decision are given in paragraph 3.0.

2.3 A RPV review meeting was held in December 1986. As a result of this meeting, the Maintenance Engineering Directorate undertook a review of the assembled inputs for reasonableness.

2.4 Preliminary study results were briefed by the Systems Analysis and Evaluation Office in March 1987 to RPV Project Office and to the Director, MLC. The results were well received. However, discussions in that meeting lead to the following modifications:

a. Rationale supporting the contention that training and publication costs were approximately the same for both the Two and Three Level Maintenance Concepts were to be developed. Justification for this contention will be presented later.

b. Manpower hours were to be displayed.

2.5 In March 1987, maintenance concept clarification from RPV Office led to adding maintenance floats (MFs) in the Two Level Concept. This proved to be a significant modification in both the additional cost imparted to the Two Level Concept, and in the effort required to phase-in this change.

2.6 Also, in March 1987, TASC began their parallel study on the Two versus Three Level Maintenance Concept Study. This necessitated coordination meetings, furnishing MICOM developed inputs, comparing study results, etc., by the MICOM primary study group. The TASC study used a model, the Life-Cycle Cost Analysis (LCCA) model, that has not been reviewed or approved for performing logistics studies of U.S. Army systems. Nevertheless, the TASC study's overall results agreed with the results reported in this document.

2.7 During March 1987 through January 1988, the study was completed and this report developed.

3.0 MODEL SELECTION. This section discusses the rationale and considerations in selecting the Optimum Supply and Maintenance Model (OSAMM) as the principal study tool.

3.1 Originally, two models were considered as potential candidates, OSAMM and the Logistics Analysis Model (LOGAM). Both models are widely used for performing evaluation of logistics support alternatives. The two models have been reviewed and each recommended as a "viable candidate for application to one or more Logistics Support Analysis (LSA) tasks during the LSA Process."*

3.1.1 There are advantages and disadvantages to both models [3] and [4]; but the principal factors that led to selecting OSAMM are:

a. The SESAME model [5], which is AMC approved, is a subroutine to OSAMM. Since SESAME is the chief model that will later be used for spare parts budgetary estimates and provisioning, its use in this study would facilitate that future work.

b. Inputs are grouped in a logical format that simplified data

***AMC-P 700-4, Logistics Support Analysis Techniques Guide - Draft, (US Army Materiel Command, 1987), page 2-1.**

base construction.

3.1.2 Even though the above factors dominated, there are some very distinct disadvantages associated with using OSAMM, some of which increased the time required to complete this study. These disadvantages are:

a. The OSAMM computer code is not available to the user. Thus, defending OSAMM answers, which requires a full understanding of the model's logic, is difficult. Also, the user must rely on the mercy of the model proponents (CECOM) to make special model changes when nonstandard study problems are encountered.

b. The OSAMM model must be executed on a time sharing computer system. There are inherent delays and inconveniences with such a system. Especially troublesome is the noise on telephone lines and having to rely on long distance consultative assistance.

c. The dollar charges for executing OSAMM and storing data files are relatively high, but not prohibitive. In the case of this study, approximately sixteen thousand dollars in computer funds were expended.

d. Only one subsystem (this study considered seven subsystems) can be evaluated, since OSAMM is not a systems model.

e. Sensitivity analysis can only be accomplished by manually changing the variable(s) of interest and submitting a new computer run for each change.

4.0 PROBLEM DESCRIPTION. This section describes in detail the problem modeled. Included are the maintenance concepts of interest, certain input adjustments, general information about the size of the problem and the test equipment and manpower, the principal input variables, the relevant study assumptions, the principal data sources and data reviews, the S&M costs that were considered and the costs that were omitted, and justification for the omitted costs. The complete set of input data and computer output, which would complete the problem description, are too voluminous to be included in this report. They are, however, available for review from the Systems Analysis and Evaluation Office or the Technical Analysis and Support Office.

4.1 SUPPORT CONCEPTS STUDIES. The support concepts of interest are shown in Table 2.

TABLE 2. Support Concepts

Support Concept	Salient Characteristics
Two Level	Maintenance Floats (MFs)* stocked at depot.
Three Level	Three level structure with contact team at each DSU.

*Per AR 750-1,"The maintenance float is a quantity of selected items of materiel authorized to have on hand at a maintenance activity for the replacement of like items evacuated for maintenance from the using units".

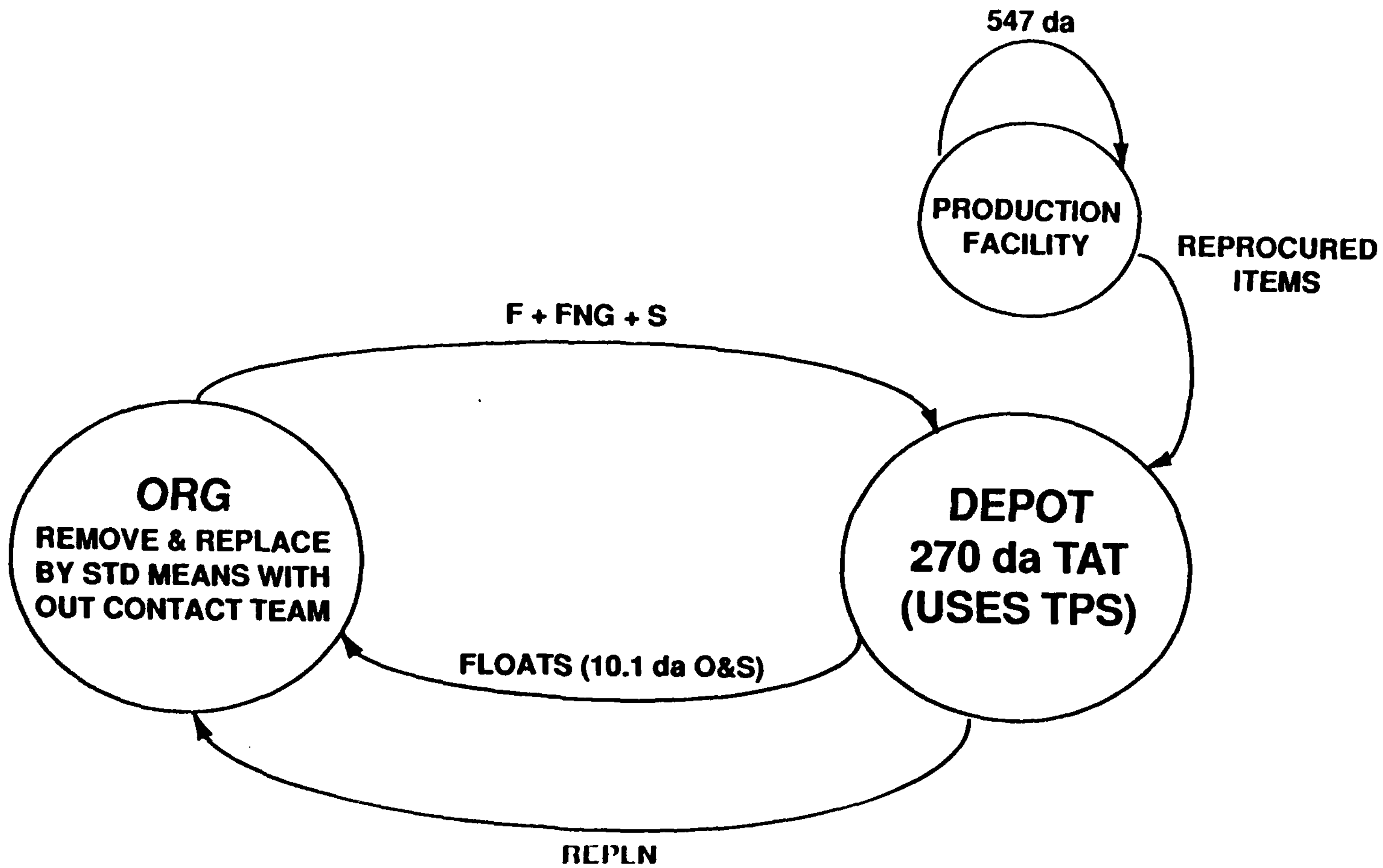
4.1.1 In the Two Level Concept, MFs must be used whenever a component fails that cannot be removed and replaced at ORG due to the nonexistence of a contact team. There is the possibility of reducing the number of MFs required through additional training at ORG, but waivers to existing military polices would have to be obtained. Waivers would be necessary to permit soldering at ORG to replace certain components in the downed subsystem; and to extend the time limits for getting the subsystem "on the air" at ORG due to contact team tasks that would be performed by ORG personnel.* The Two Level Concept with MFs stocked at Depot, however, is a feasible two level concept; while the concept with additional training to reduce the number of MFs is currently infeasible.

4.1.2 In the Three Level Concept, a contact team has the capacity to remove and replace those components which the ORG cannot. Thus, floats, having the same function as those used in the Two Level Concept, are not required.

4.1.3 To aid in understanding the two maintenance concepts of interest, a materiel flow overview is given in Figures 1 and 2. These figures are simplifications of the materiel flow that were actually modeled.

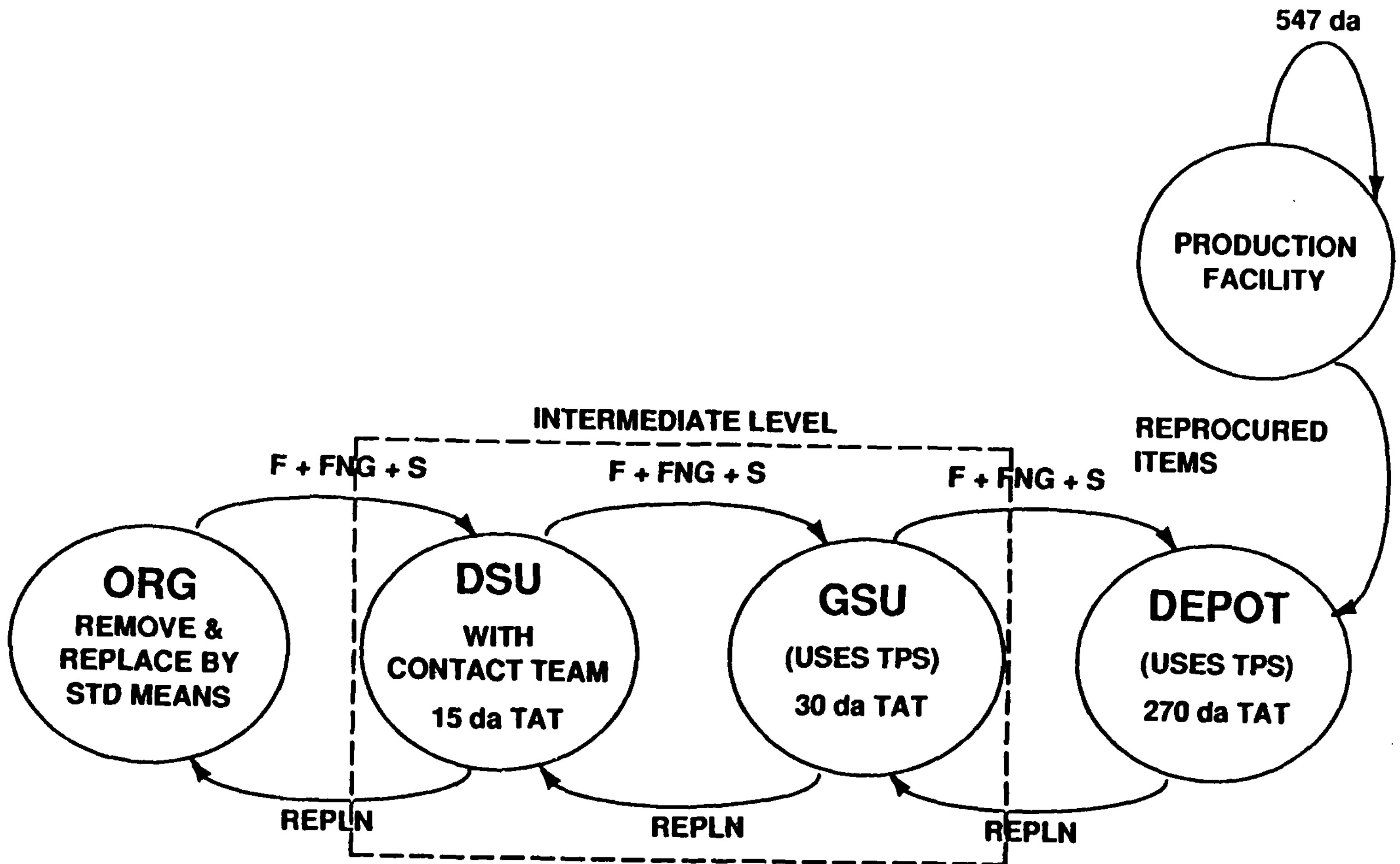
4.2 INPUT ADJUSTMENTS TO MODEL THE TWO LEVEL CONCEPT. Since OSAMM is not designed to consider MFs, special adjustments were made. These adjustments are described, in general, below. The authors of this report can be consulted for specifics. Basically, MFs were input as an OSAMM, component or line replaceable unit (LRU). Components (LRUs) that cause the subsystem to be floated are input as an OSAMM module, and modules are input as OSAMM parts. However, parts are ignored

***SOURCE: AMCPM-RP and AMSMI-LC-ME, March 1987.**



F - FAILURES	O&S - ORDER & SHIP TIME
FNG - FALSE-NO-GO	TAT - TURN-AROUND TIME (INCLUDES O&S)
S - SCRAP	TPS - TEST PROGRAM SETS
REPLN - REPLENISHMENT	

FIGURE 1 - TWO LEVEL CONCEPT MATERIEL FLOW OVERVIEW



F - FAILURES
FNG - FALSE-NO-GO
S - SCRAP
REPLN - REPLENISHMENT

O&S - ORDER & SHIP TIME
TAT - TURN-AROUND TIME (INCLUDES O&S)
TPS - TEST PROGRAM SETS

FIGURE 2 - THREE LEVEL CONCEPT MATERIEL FLOW OVERVIEW

since OSAMM cannot model more than three indentures. The problems with this approach are: modules are input as OSAMM parts and OSAMM discards parts; and actual parts are omitted. In order to overcome this deficiency, a computer program was developed based on recommendations from AMSAA Army Inventory Research Office* that compensated for these problems by adjusting the input price of OSAMM parts. Also, care was taken to ensure there was no test equipment used by modules that was "dropped" as a result of modules being input as OSAMM parts.

4.3 PROBLEM SPECIFICS. The number of RPV batteries by theater are shown in Table 3.

TABLE 3. RPV Batteries by Theater

THEATER	NUMBER OF BATTERIES
Korea	1
Europe	4
CONUS	4
TOTAL	9

Thus, there are a total of nine RPV batteries considered.

4.3.1 The world-wide density based on the above number of batteries fielded to force structure is shown in Table 4.

TABLE 4. Selected RPV Subsystem Statistics

NOMENCLATURE	DENSITY	COST*	WORLD-WIDE FAILURES**	NO. ITEMS
Air Vehicle	117	.35	270	137
Launcher	18	.03	133	150
Recovery	18	1.14	626	[illegible]
Ground Control Station	45	2.21	5407	226
Maintenance Shelter	9	.92	1162	56
Air Vehicle Handler	18	.31	348	26
Training Interface Unit	18	.65	[illegible]	26

***AMSAA is well-qualified to make such recommendations since they originated the OATMEAL model [6] which is called OSAMM by CECOM.**

TABLE 4. - Continued.

*	Hardware cost (1987 $ in millions).
**	World-wide failures equals lifetime X operating hrs per yr X density X no. subsystem failures per operating hr.

Other informative statistics, in Table 4, on subsystem cost and failures show the common condition of the highest dollar subsystem having the highest number of failures. Thus, it is reasonable to expect that these high-dollar, high-failure rate subsystems will have the highest S&M costs.

4.3.2 The logistics support structure and the echelons which employ test programs sets (TPS) are shown in Table 5. The TPS candidates were associated on input with specific components (LRUs) and modules. This allowed OSAMM, with its minimization routines, to choose between selecting the number of TPS and locations (GSU or Depot) to accomplish repair versus discard. The cost of developing, replicating and annual updating were modeled for each TPS.

TABLE 5 Logistic Support Structure

LOGISTIC SUPPORT STRUCTURE

SUPPORT LEVEL	NUMBER OF SUPPORT UNITS	TPS* 2-LEVEL	TPS* 3-LEVEL
ORG	9	NO	NO
DS	9	NO	NO
GS	6	NO	YES
DEPOT	1	YES	YES

*TPS - Test Program Sets.

4.4 EQUIPMENT AND MANPOWER. Certain test equipment and manpower inputs were given full costs, if dedicated to RPV, or a fractional cost based on usage, if shared. This equipment and manpower is summarized in Table 6.

TABLE 6. Test Equipment and Manpower Classified as Dedicated(D) or Shared(S)

TEST EQUIPMENT	MANPOWER
TPS(D)	Contact Team(D)
IFTE(S)*	Test & Repair(S)

*IFTE - Intermediate Forward Test Equipment.

4.4.1 CONTACT TEAM. Costs for the Contact Team and associated vehicles were developed by hand (See Appendix A.) and prorated to each subsystem. The proration is based on the fraction of failures a contact team removes and replaces for each subsystem.

4.5 INPUTS. This section discusses input adjustments made to effectively model the "problem at hand" via OSAMM, and other inputs considered.

4.5.1 INPUT ADJUSTMENTS. Two special input adjustments were made for running all theaters simultaneously since OSAMM is designed to estimate S&M costs by theater. These adjustments consisted of:

a. Weighting mileage between theater by theater density ratios, as shown in Example 1, for Depot only.

b. Adjusting the subsystems meantime to repair to reflect MI theater dependent order and ship times as shown in Example 2. The actual adjustments appear in Table 7.

Other theater specific inputs, such as ORG to DSU miles, DSU to GSU miles, order and ship times, shift hours per day, days per workweek, procurement lead-time, or contact team delay time were assumed constant between theaters.

Example 1. Method for Weighting GSU to Depot Miles

$$M = R_1 \times KD + R_2 \times ED + R_3 \times CD$$

M - Weighted GSU to Depot mi.
R_1 - Korea density ratio (1/9).
R_2 - Europe density ratio (4/9).

Example 1. – <u>Continued.</u>

R_3 – CONUS density ratio (4/9).
KD – Distance, Korea to CONUS Depot (4375 mi).
ED – Distance, Europe to CONUS Depot (6260 mi).
CD – Distance, CONUS to CONUS Depot (1250 mi).
X – Multiplication Operator.

$$M = 1/9\ (4375) + 4/9\ (6250) + 4/9\ (1250) = 3820^{*}\ \text{mi.}$$

*This is the value used in this study for GSU to Depot mi.

Example 2. Method for Adjusting Subsystem Mean Time to Repair for MF Order and Ship Times

$$MTRF_i = F_i \times WD + (1 - F_i) \times MTR_i$$

$MTRF_i$	–	Mean time to repair the ith subsystem adjusted for MF order and ship times.
F_i	–	Fraction of failures requiring an MF for subsystem i.
X	–	Multiplication Operator.
MTR_i	–	Mean time to repair a subsystem without MF order and ship times, but including time required to transport the subsystem to organization or the time it takes organizational personnel to travel to the user.

$$WD = (R_1 \times KS + R_2 \times ES + R_3 \times CS) \times 24$$

WD	–	Weighted MF order and ship times in hrs.
R_1, R_2, R_3	–	As defined in Example 1
KS	–	Korea order and ship time for an MF ([illegible] da).
ES	–	Europe order and ship time for an MF ([illegible] da).

Example 2. - Continued.

CS - CONUS order and ship time for an MF (14 da).

WD = [1/9 (7) + 4/9 (7) + 4/9 (14)] X 24 = 242.66 hrs.

TABLE 7. Adjusted Mean Time to Repair Values for MFs

SUBSYSTEM	$MTRF_i$* (Hrs)	F_i	MTR_i (Hrs)
Air Vehicle	16.23	.059	[illegible]
Launcher	26.65	.106	1.10
Recovery	2.06	.005	.75
Ground Control Station	42.47	.172	[illegible]
Maintenance Shelter	77.83	.319	[illegible]
Air Vehicle Handler	.67	.0002	[illegible]
Training Interface Unit	.52	0	.52

*Adjusted via Example 2 for use in Two Level Concept.

4.5.2 OTHER INPUTS CONSIDERED. Other inputs used in this study are:

a. Component and module level detailed inputs (MTBFs, costs, test and repair time, weights, piece part cost per repair action, essentiality codes and washout rates.

b. Standard values were used for other inputs; that is, for order and ship times, operating levels, turnaround times, labor rates, administration costs and transportation costs.

4.6 DATA BASE CONSTRUCTION. The principal data sources are:

a. Lockheed Missile and Space Company Inc., Austin, Texas.

b. MLC, Maintenance Engineering Directorate.

c. Remote Piloted Vehicle Project Office.

Inputs from these sources were reviewed for accuracy, reasonableness and conformity with model definitions by the RPV Two versus Three Maintenance Support Concept Study Team.

4.7 LOGISTIC COSTS. The logistic cost categories included in this study and the costs omitted are shown in Table 8. It is these costs that are referred to as S&M costs. Costs in this study are in 1987 dollars. Also, costs are discounted by mid-year tables at a fixed rate of 10 percent per DODI 7041.3, Economic Analysis and Program Evaluation for Resource Management, October 1972.

TABLE 8. S&M Logistic Cost Categories

COST CATEGORIES INCLUDED
Initial Spares Consumption Spares Transportation Manpower and Contact Team Training Test Measurement and Diagnostic Equipment (TMDE) Miscellaneous: (Supply Administration, Reordering, Requisitioning, Storage)
COST CATEGORIES OMITTED
Training* (Selected Areas) Publication*
*There is no appreciable cost difference between the Two and Three Level Concepts for these categories.

4.7.1 TRAINING COSTS. Table 9 gives an analysis of one time training costs for instructors and key personnel.

TABLE 9. Two/Three Level Training Analysis
for Instructors and Key Personnel

MAINTENANCE LEVEL	2 LEVEL COURSE CONDUCT HRS	3 LEVEL COURSE CONDUCT HRS
Unit	533*	400
Intermediate	0	664
Depot	771*	240
Total	1304	1304

Source: AMSMI-LC-ME-N

*Assumes 20% Intermediate Level training conduct hrs is transferred to Unit Level and 80% to Depot.

Since the total course conduct hours is the same for both the Two and Three Level Support Concepts, it is concluded that the cost savings from eliminating intermediate level instructor and key personnel training in the Two Level Concept is offset by the cost increase in unit and Depot training.

4.7.1.1 A significant portion of the training cost stems from an Army policy* which dictates that certain shared test and repair manpower will be given RPV peculiar training if colocated with a RPV Battalion. In this study, this shared manpower, which are not a "wash" between the Two and Three Level Concepts, happens to correspond to the military occuptional specialities (MOSs) in the RPV Contact Team. For this reason, even though the training is not a contact team cost per se, it will be combined in Appendix A with the costs for the Contact Team. In the Two Level Concept there is no effect for such an Army policy for the MOSs which are not a "wash".

4.7.1.2 Other training (one-time per accession and other recurring training) is a "wash", except for the Contact Team, since manpower requirements are "sufficiently close" for both concepts (see paragraph 6.3.1). The training costs for the Contact Team, which are not omitted, are developed in Appendix A.

4.7.1.3 In summary, one-time instructor and key personnel training is a "wash" for both the Two and Three Level Support Concepts. Training costs for shared manpower receiving peculiar RPV training is developed and combined with the contact team costs. One-time per accession and other recurring training is a "wash" except for the Contact Team.

***SOURCE: AMSMI-LC-ME-N**

Thus, only the Contact Team one-time per accession and recurring training costs and the costs for shared manpower receiving RPV peculiar training are developed in this study.

4.7.2 PUBLICATION COSTS. Table 10 gives on analysis of publication costs. Since the total number of publication pages is the same for both support concepts, the cost savings from eliminating intermediate level publications is offset by the cost increase in ORG and Depot publications.

TABLE 10. Two/Three Level Publication Analysis

MAINTENANCE LEVEL	2 LEVEL PUB. PAGES	3 LEVEL PUB. PAGES
Unit	8211*	7550
Intermediate	80	3307
Depot	9709*	7063
RPSTL**	3600	3600
TOTAL	21520	21520

SOURCE: AMSMI-LC-ME-PMS
*Assumes 20% Intermediate Level pubs is transferred to ORG Level and 80% is transferred to Depot.
**Repair parts & special tool.

4.8 PROVISIONING LINE UPDATE COSTS. Since provisioning records are already established for a Three Level Concept, a cost will be incurred to modify the existing records for a Two Level Concept. Appendix B develops these costs by subsystem.

4.9 ASSUMPTIONS. In addition to what has already been discussed, other relevant assumptions influencing the study are as follows:

a. Deployment is constant throughout a fifteen year lifetime.

b. Inherent failures, rather than failure factors, are accurate enough to allow valid study conclusions.

c. RPV will be supported at an organic depot as opposed to a strictly contractor operated depot.

d. Commercial equivalent equipment (CEE) is a "wash" between concepts.

e. Dedicated RPV operators/crewmen and operator/mechanic are a "wash" between support concepts.

f. The standard OSAMM and SESAME modeling assumptions given by [1], [5] and [6] are applicable to this study.

g. The direct exchange stockage option from SESAME is appropriate. (Actually, computer results gave almost no differences for the RPV subsystems studied when trying each of the three possible stockage options; namely, vertical, non-vertical and direct exchange.) The main study assumptions are summarized in Table 11 for convenience.

TABLE 11. Main Study Assumptions

ASSUMPTION	TWO LEVEL CONCEPT	THREE LEVEL CONCEPT
World-Wide Deployment	Yes	Yes
Constant Deployment	Yes	Yes
TPS	Yes	Yes
CEE A Wash	Yes	Yes
Contact Team	No	Yes
Prov. Line Update*	Yes	No
Organic Depot	Yes	Yes
DMPE A Wash* (or at most min cost impact)	Yes	Yes
ILS-MANPRINT A Wash* (or at most min cost impact)	Yes	Yes
Pub. A Wash* (or at most min cost impact)	Yes	Yes
Instructor & Key* Personnel Training A Wash	Yes	Yes
One Time per accession & recurring training A WASH	Yes	Yes (except Contact Team)
Inherent Failures	Yes	Yes
IFTE Shared	Yes	Yes

*SOURCE: Various Organizations in MLC

5.0 STUDY APPROACH. The principal areas of concern in this section are:

a. Over what A_o should MIDs be developed in order to realistically compare the Two and Three Level Maintenance Concept costs?

b. How to reach valid conclusions even when specific A_o targets cannot be achieved in the real-world due to inadequate stocks?

5.1 The first concern was solved by developing MTDs at maximum possible* operational availability (A_o)+ for each subsystem. This is compatible with the acceptable approach of developing MTDs for wartime conditions. Thus, under peacetime conditions which are modled for this study, lifetime costs are estimated assuming peace operating hours with wartime MTDs.

5.2 The second concern was solved by performing sensitivity analysis for all possible A_o targets due to stockage variations only. Thus, the problem of whether or not a specific A_o can be achieved, at least due to stockage considerations, was avoided. Incidentally, sensitivity analysis was not performed on other parameters influencing A_o due to the large number of computer runs required. Thus, the decision was reached to develop S&M cost versus A_o curves with A_o varying over its total possible range.

5.3 In summary, the following study approach was employed: S&M cost versus A_o curves were computed by OSAMM with A_o varying over its total possible range. The curves were computed for:

a. Each RPV subsystem of interest.

b. Both Two and Three Level Support Concepts.

c. For peace operating hours with wartime MTDs developed at MAX A_o.

*In practice, the theoretical maximum for A_o may not be achieved due to SESAME's methodology.

+OSAMM estimates A_o by:

$$A_o = \frac{MCTBF}{MCTBF + MTR + MTT + MLDT}$$

where: MCTBF - Mean Calendar Time Between Failures.

MTR - Mean Time to Repair, if all resources are available.

MTT - Mean Transportation Time.

MLDT - Mean Logistic Down Time to get an essential component from the supply system. Estimated by SESAME.

REMOTELY PILOTED VEHICLE

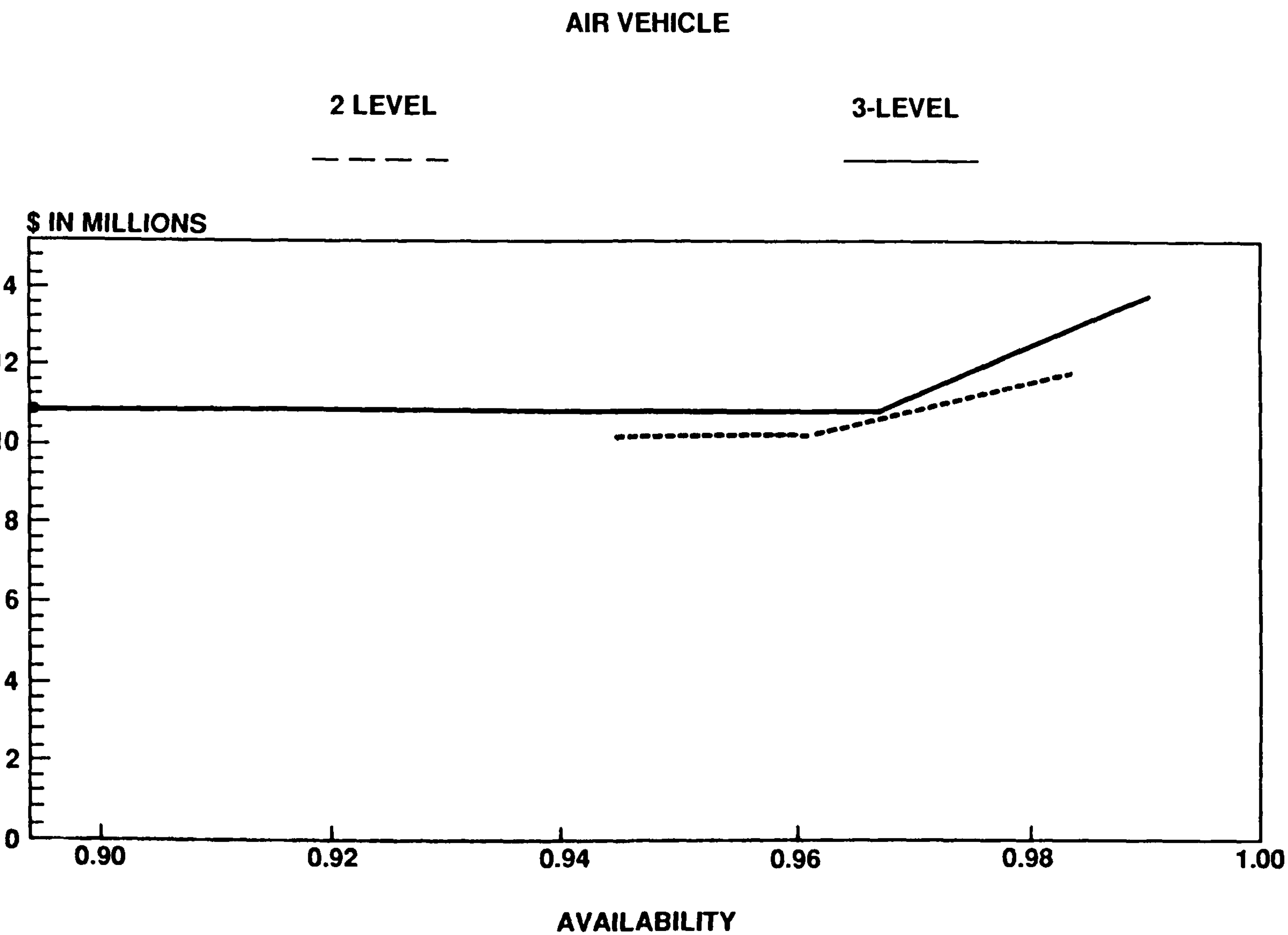


FIGURE 3 - AIR VEHICLE S&M COST VERSUS A_o

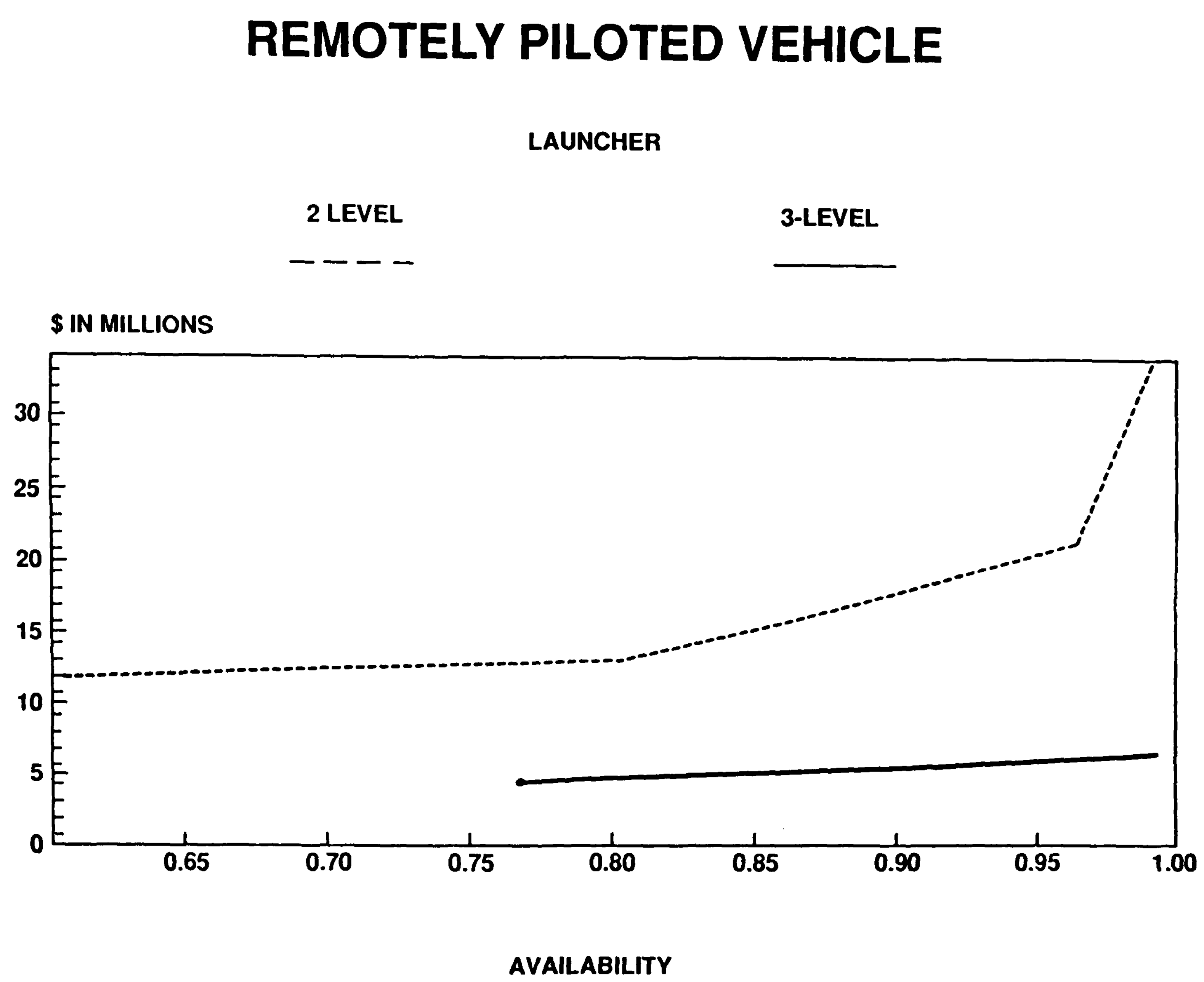


FIGURE 4 - LAUNCHER S&M COST VERSUS A_o

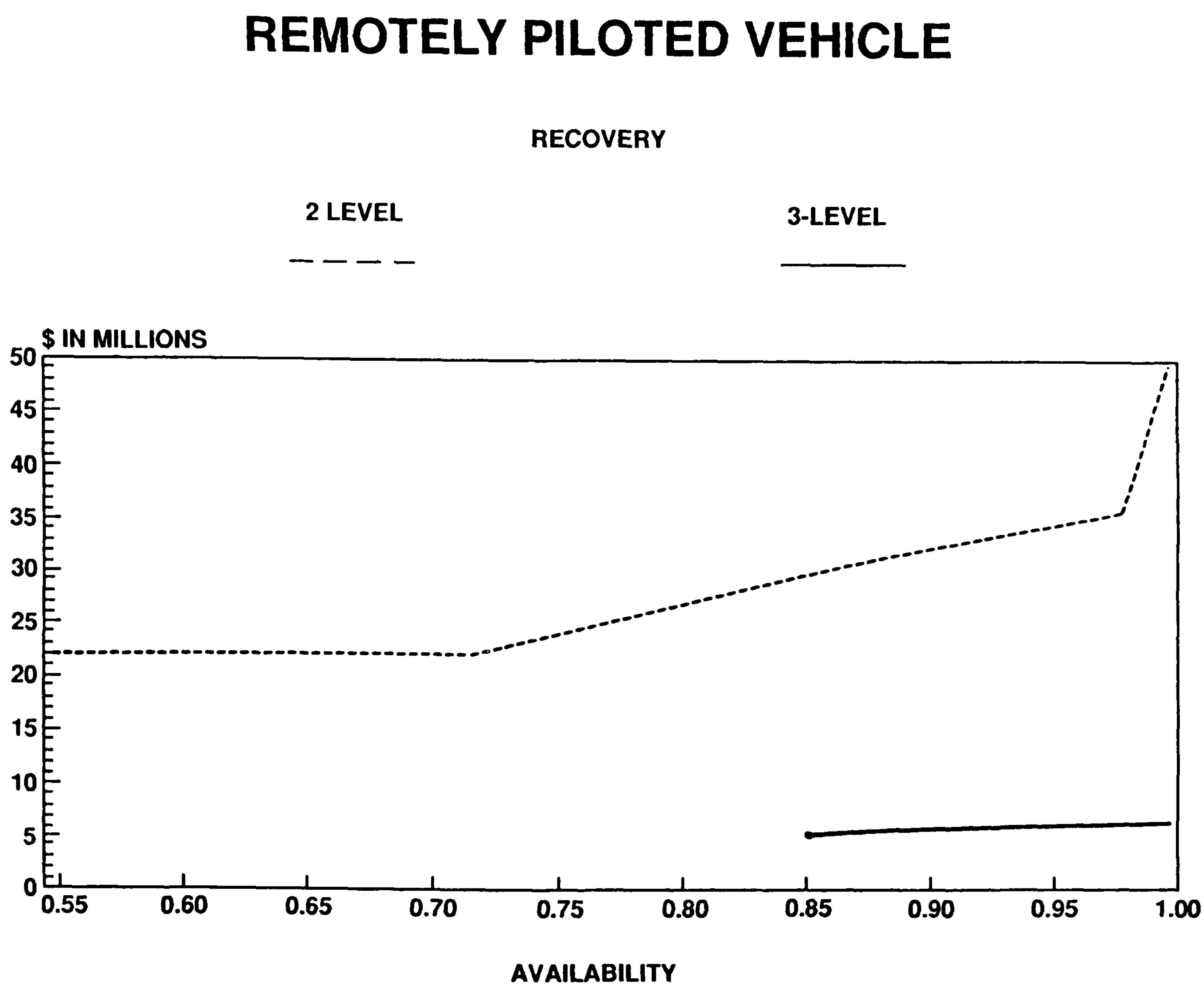


FIGURE 5 - RECOVERY S&M COST VERSUS A_o

REMOTELY PILOTED VEHICLE

GROUND CONTROL STATION

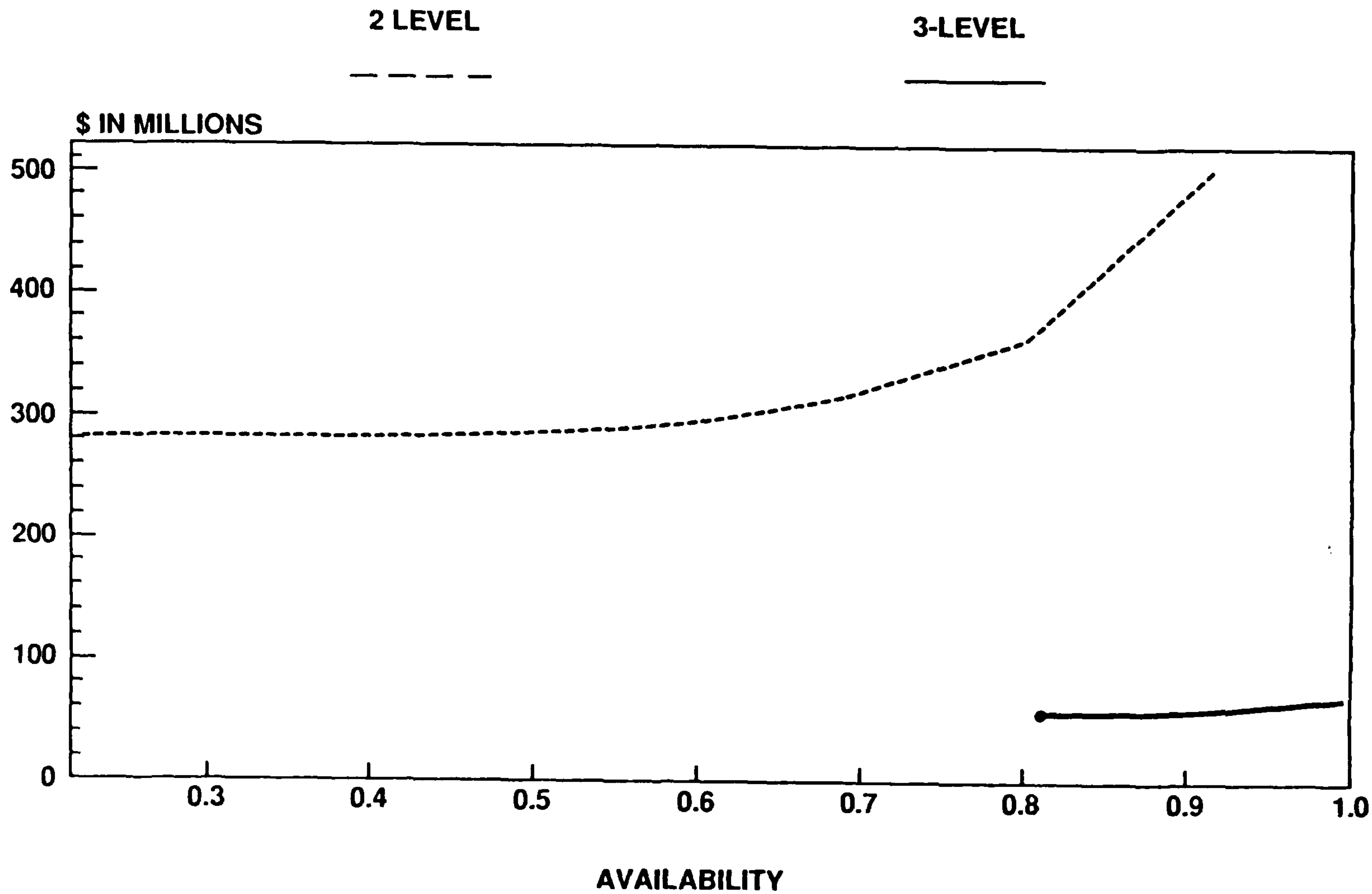


FIGURE 6 - GROUND CONTROL STATION S&M COST VERSUS A_o

REMOTELY PILOTED VEHICLE

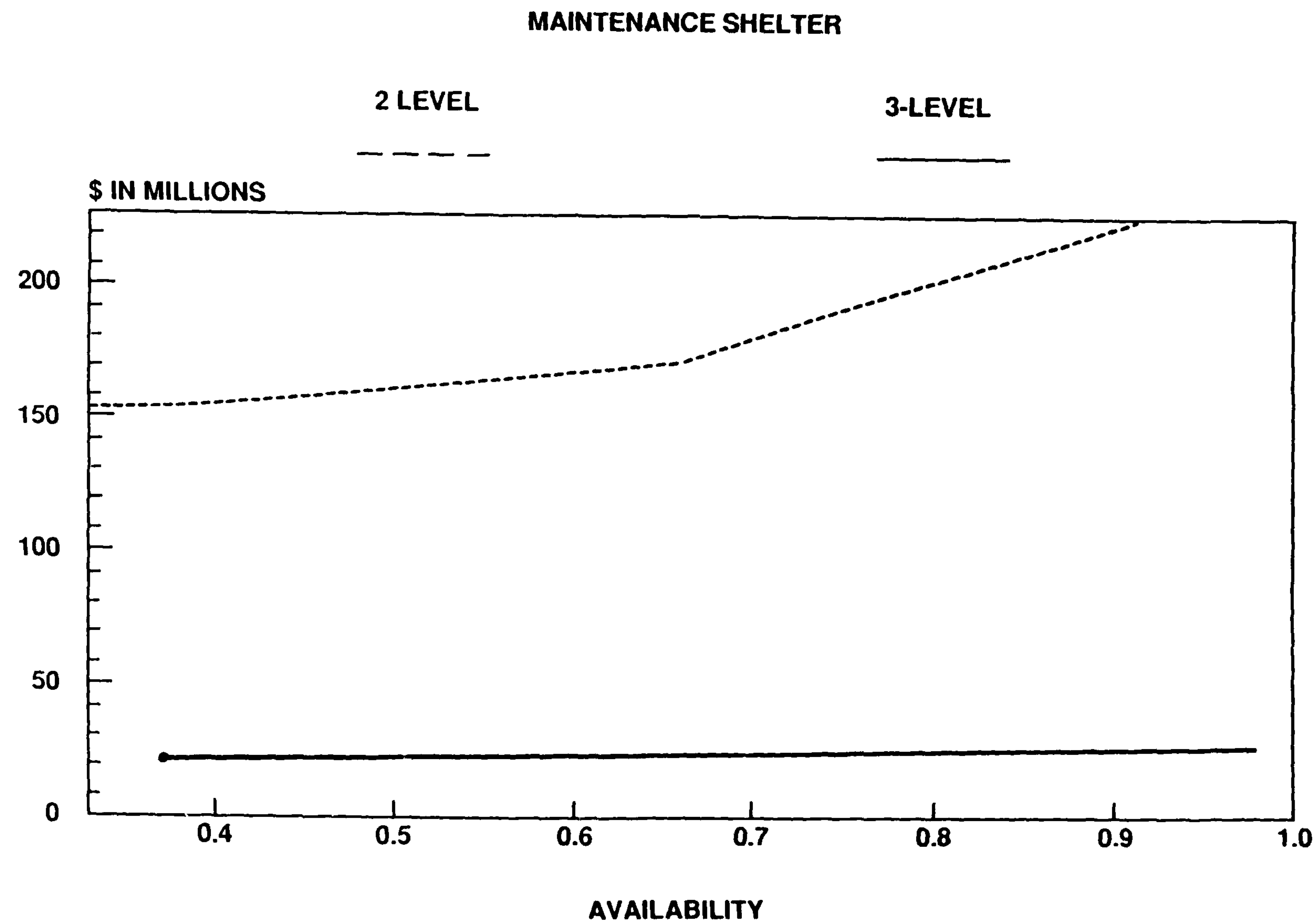


FIGURE 7 - MAINTENANCE SHELTER S&M COST VERSUS A_o

REMOTELY PILOTED VEHICLE

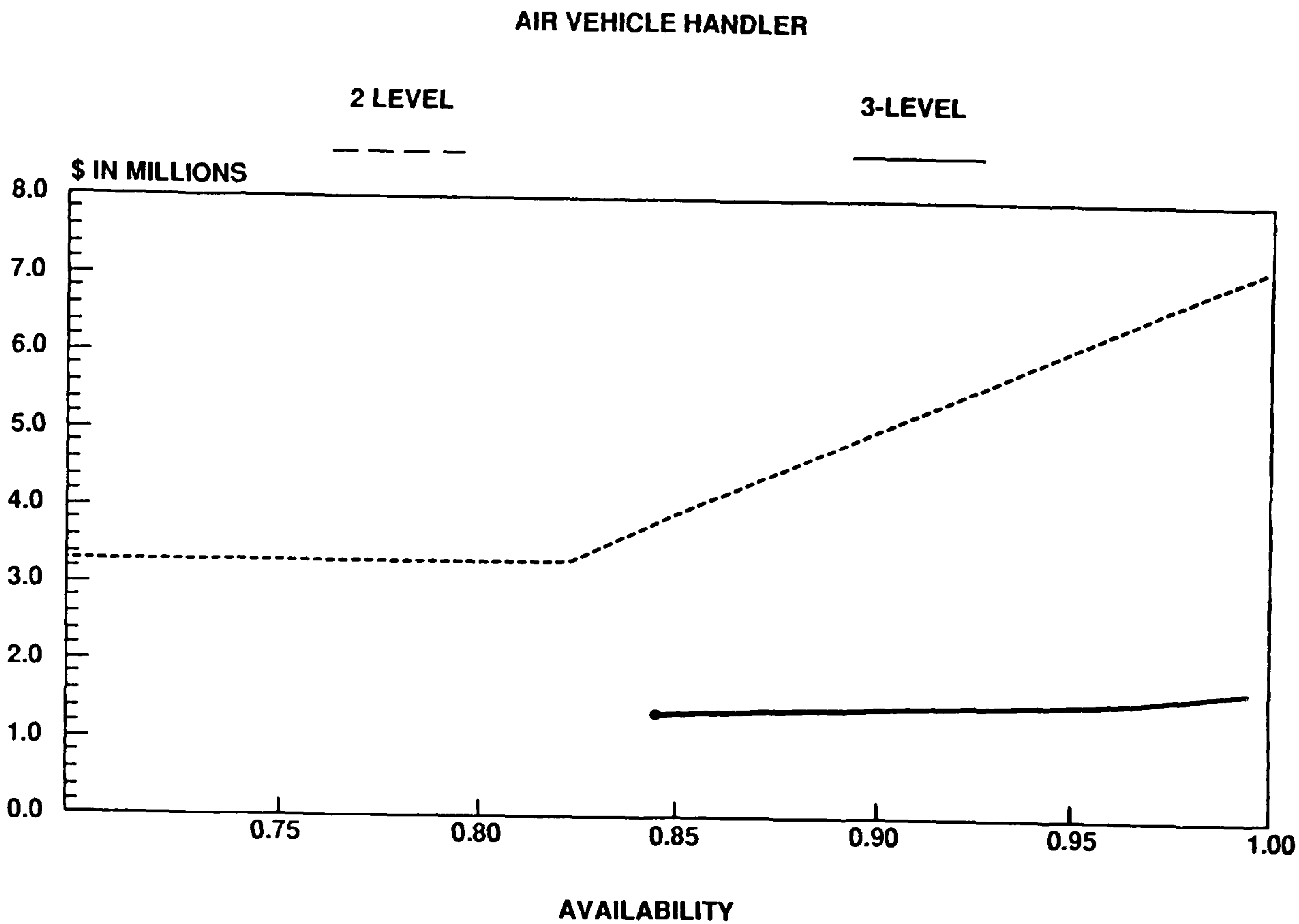


FIGURE 8 - AIR VEHICLE HANDLER S&M COST VERSUS A_o

REMOTELY PILOTED VEHICLE

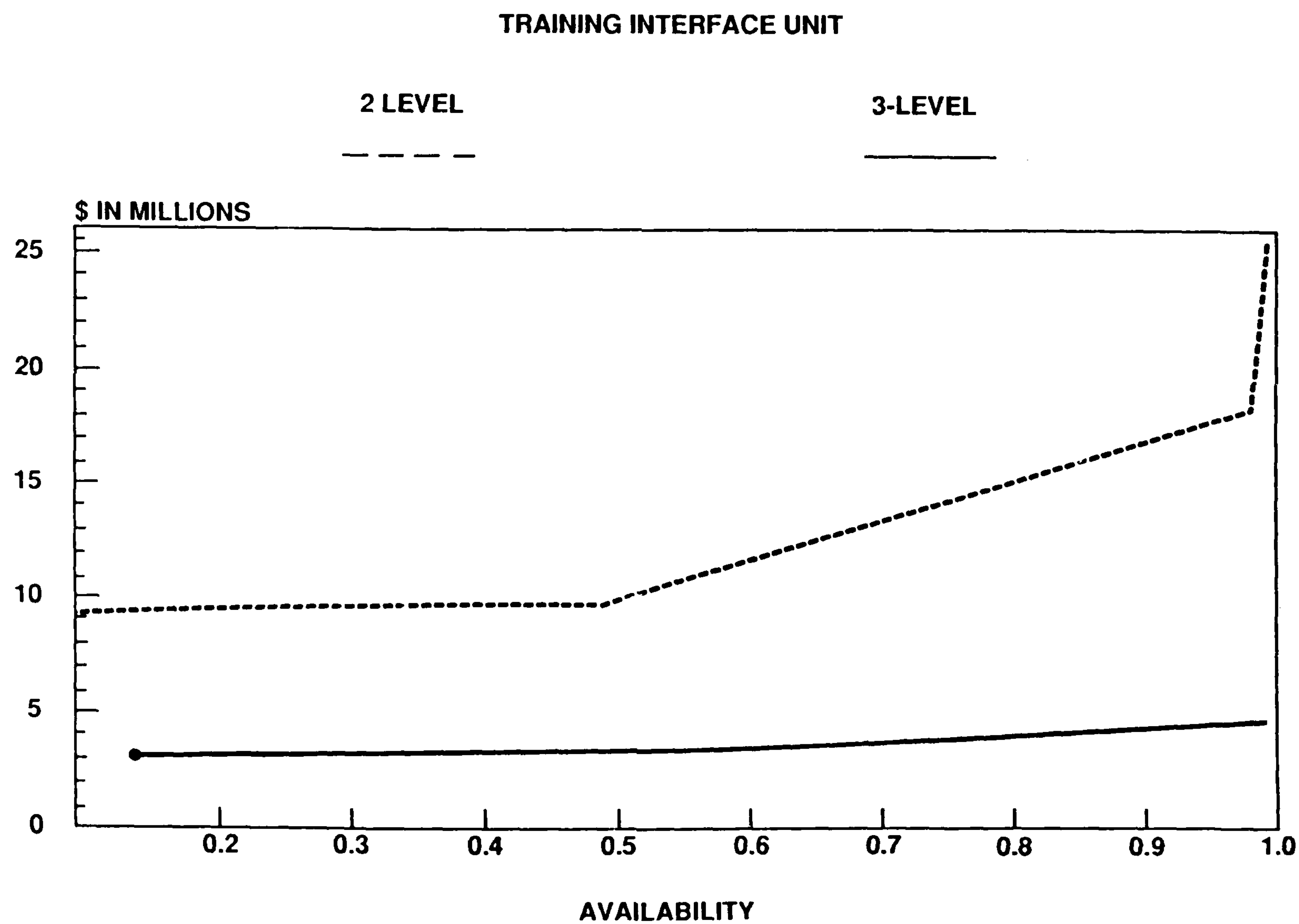


FIGURE 9 - TRAINING INTERFACE UNIT S&M COST VERSUS A_o

6.0 STUDY RESULTS. This section addresses findings on the single objective of this study; namely, to determine the least costly approach between the Two and Three Level Maintenance Concepts. Also, addressed are certain "side" results regarding the potential operational availability that each concept can achieve, and why improvements in operational availability is possible from small stockage cost increases. Finally, explanations are given for the logistic cost difference behavior between the Two and Three Level Concepts.

6.1 S&M COST CURVES VERSUS A_o. The following series of seven figures, Figure 3 through 9, show the S&M cost curves at all possible A_o for each subsystem of interest. Contact Team costs and provisioning line up date costs are included in the above figures. The numerical values used to construct these curves can be found in Appendix C.

6.1.1 In each of the above seven figures, the minimum availability shown is at what SESAME terms "SIP" (Standard Initial Provisioning) stockage. It is generally unreasonable to stock below SIP since once a system is operating on demand data, stockage costs will be at least as great as SIP costs*.

6.1.2 The maximum availability shown in each of the above seven figures is limited by the subsystem mean time to repair and mean calendar time between failures.

6.1.3 Only one of the subsystems, the Air Vehicle in Figure 3, shows slightly lower costs for the Two Level Concept. This is attributed to the very low hardware cost, failure rate, operating hours (See Table 4.) and shipping weight (265.6 lbs). For the few failures that do occur, roughly the same dollar stock quantities for both support concepts (Two and Three Level) are sufficient to maintain a high availability. The low hardware cost and low failures prevent the dollar cost for MFs in the Two Level Concept from being appreciable.

6.1.4 The remainder of the subsystems in Figures 4 through 9 show the Two Level Concept is more costly than the Three Level Concept overall A_os.

6.1.5 It is observed, from Figures 3, 6 and 7, or Table 19, that the Three Level Concept did achieve a higher A_o for the Air Vehicle, Ground Control Station and the Maintenance Shelter subsystems. This characteristic is due, in theory, to a lower limit on the Two Level Concept's availability caused by MFs inflicting higher subsystem mean time to repair numbers, as shown in Table 7. The fact that the Launcher, Recovery,and Air Vehicle Handler subsystems had slightly higher A_os for the Two Level Concept, even though they also have higher mean time to repair, is attributed to rounding to obtain whole stockage numbers together with the methodology employed by SESAME.

*Source: US Army Materiel Systems Analysis Activity - Inventory Research Office (AMSAA-IRO).

This discrepancy is not believed to have a significant impact on costs for the Three Level Concept because:

a. The cost curves (See Figures 4, 5 and 8.) are increasing slowly at MAX A_o.

b. The MAX A_o achieved is very high (greater than .99) and a slightly higher A_o should not adversely increase costs.

Incidentally, the Training Interface Unit (See Figure 9.) achieved a slightly higher A_o for the Two Level Concept, which is reasonable, since it was not constrained by MFs.

6.1.6 One surprising result for the Three Level Concept, for all seven subsystems of interest, is that the S&M cost curves increase only slightly as A_o increases except at extremely high A_os. An inquiry revealed that there are enough low cost, high failure critical items that, when stocked in higher numbers, will improve A_o at minimal costs. Thus, higher A_os are attainable for each subsystem studied in the Three Level Concept from low cost stockage expenditures.

6.2 COST SUMMARIES. Figures 10 through 13 are summaries of the maintenance concept cost differences for the seven subsystems addressed in this study. The total cost *differences (or savings)* in these figures can be obtained from Figures 3 through 9. For MIN A_o, the total cost difference is found by subtracting the Three Level Concept cost from the Two Level Concept cost for each subsystem at the MIN A_o and totaling the results. These costs are shown in Figures 10 and 12. The same procedure is repeated for MAX A_o, the results of which are shown in Figures 11 and 13. The MIN A_o and MAX A_o were chosen for cost summaries since they correspond to the lowest and highest costs, respectively that is required to operate each subsystem. (Note: the MIN A_o and MAX A_o occur at a different A_o for each support concept.) The question answered by subtracting and totaling the costs for two different support concepts at MIN or MAX A_o is: What is the total cost difference (or savings) between the Two and Three Level Concepts if each subsystem is operating at MIN A_o (which corresponds to minimum required stockage cost), or at MAX A_o (which corresponds to maximum required stockage cost)?

6.2.1 Figures 10 and 12 are presented by subsystem. They show the cost differences (or savings) for using the Three Level Concept. The total cost differences will range between $396M to $730M depending on the average A_o the various subsystems will operate at for their lifetime.

6.2.2 Figures 11 and 13 are presented by logistic category for MIN A_o and MAX A_o, respectively. For these figures, vehicle costs to support the Contact Team are added to TMDE costs, while other Contact Team dedicated costs are added to manpower. See Appendix A for details.

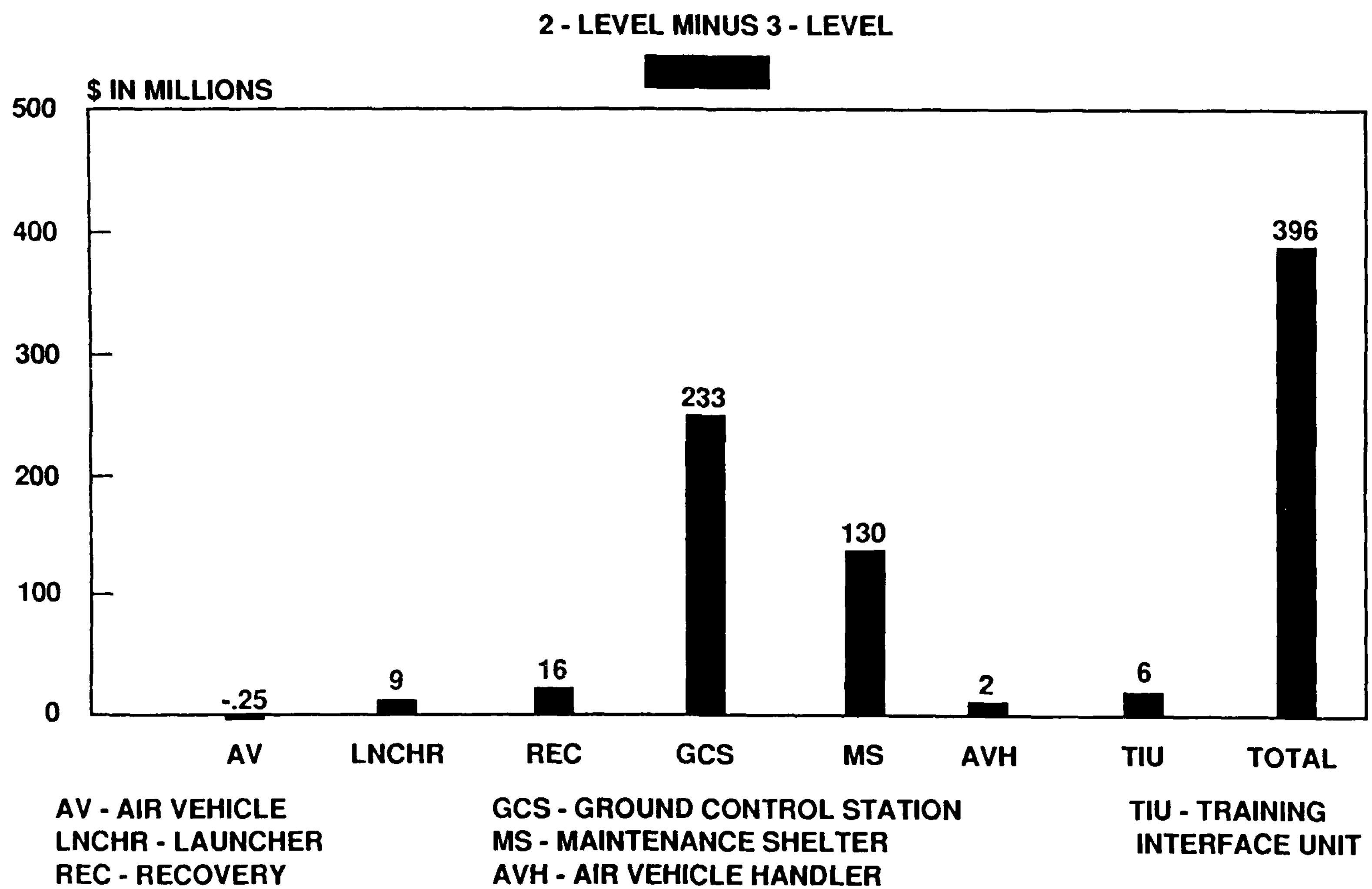
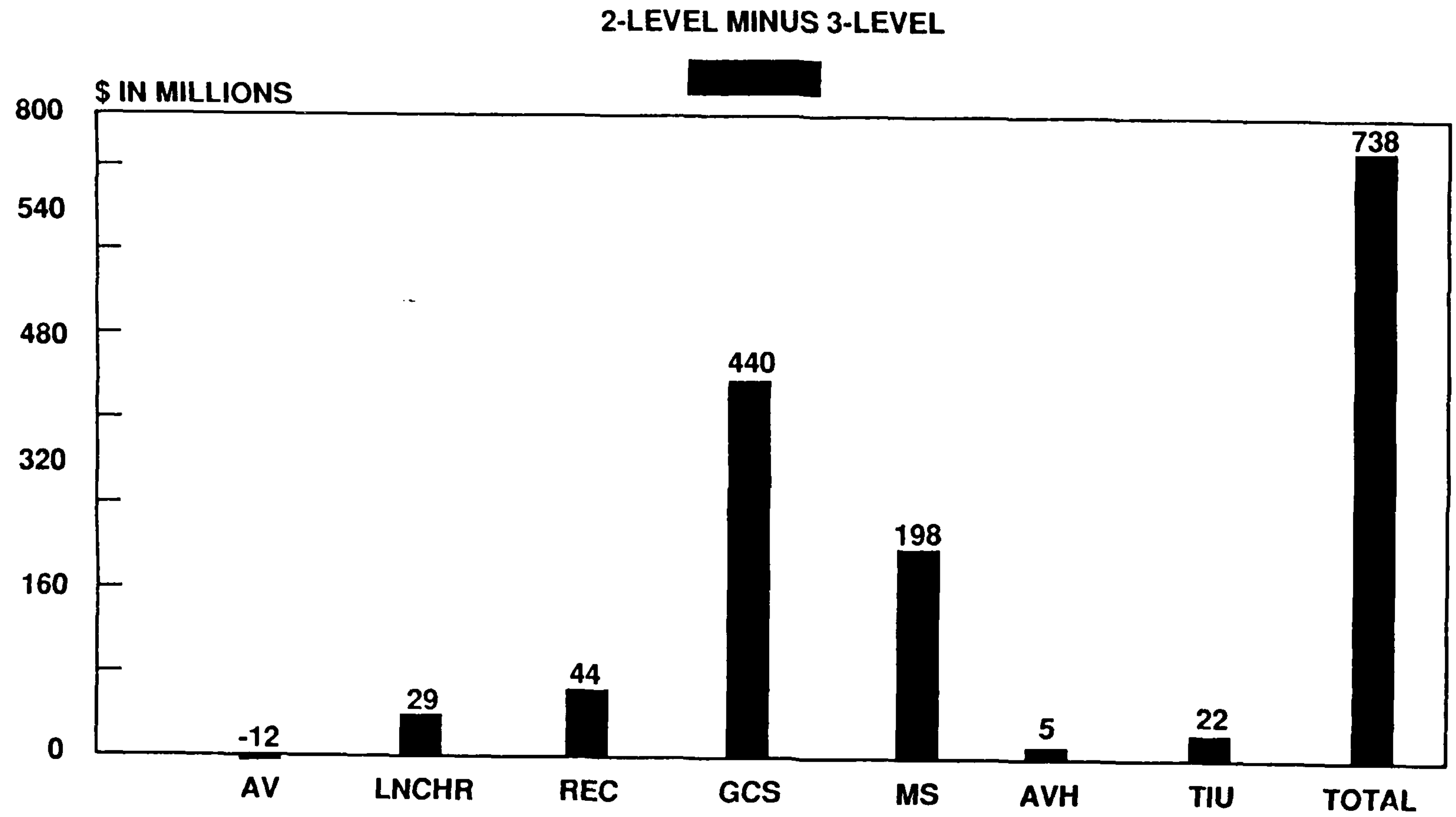


FIGURE 10 - MAINTENANCE CONCEPT COST DIFFERENCES BY SUBSYSTEM AT MIN A_o

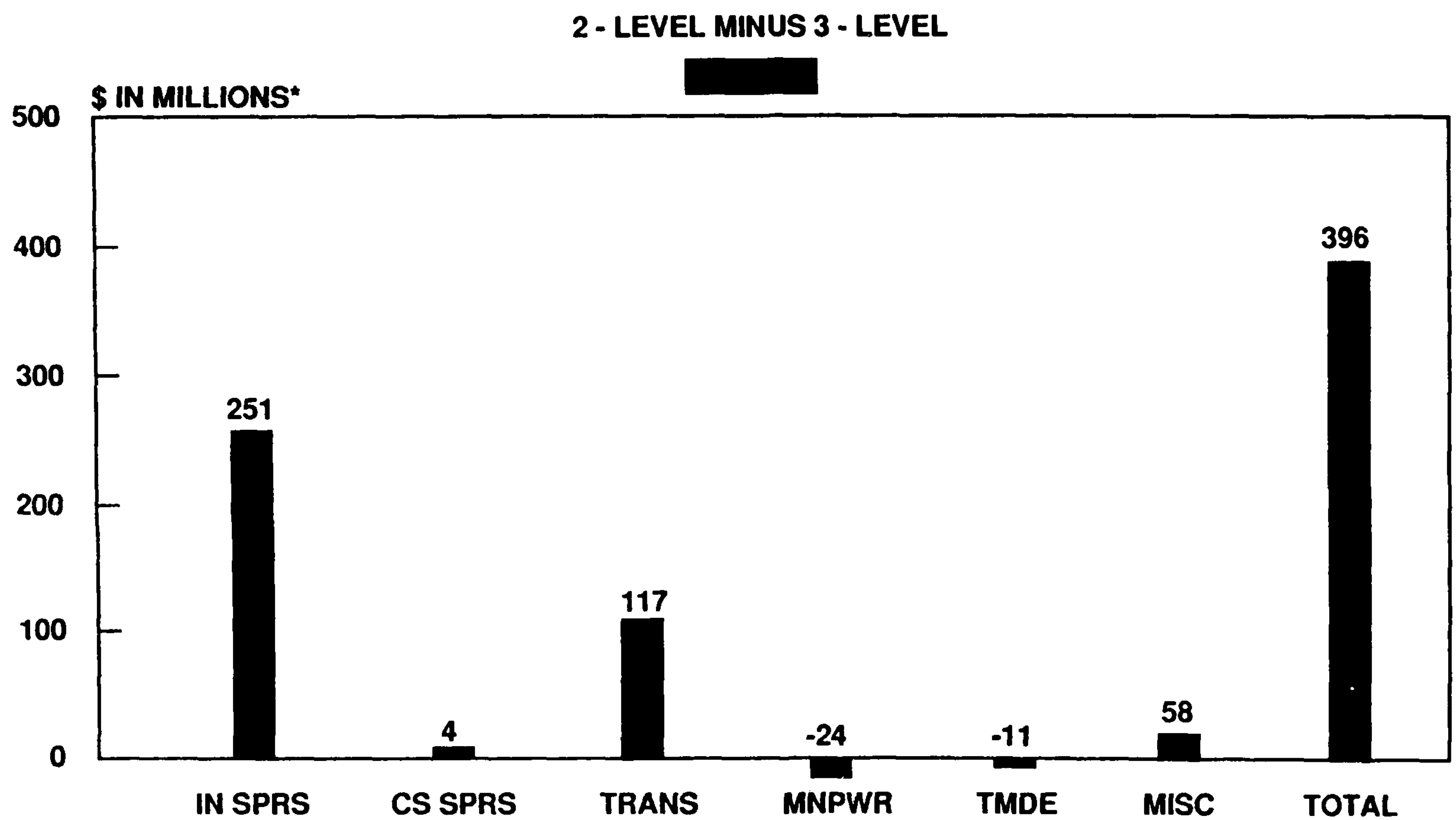


AV - AIR VEHICLE
LNCHR - LAUNCHER
REC - RECOVERY

GCS - GROUND CONTROL STATION
MS - MAINTENANCE SHELTER
AVH - AIR VEHICLE HANDLER

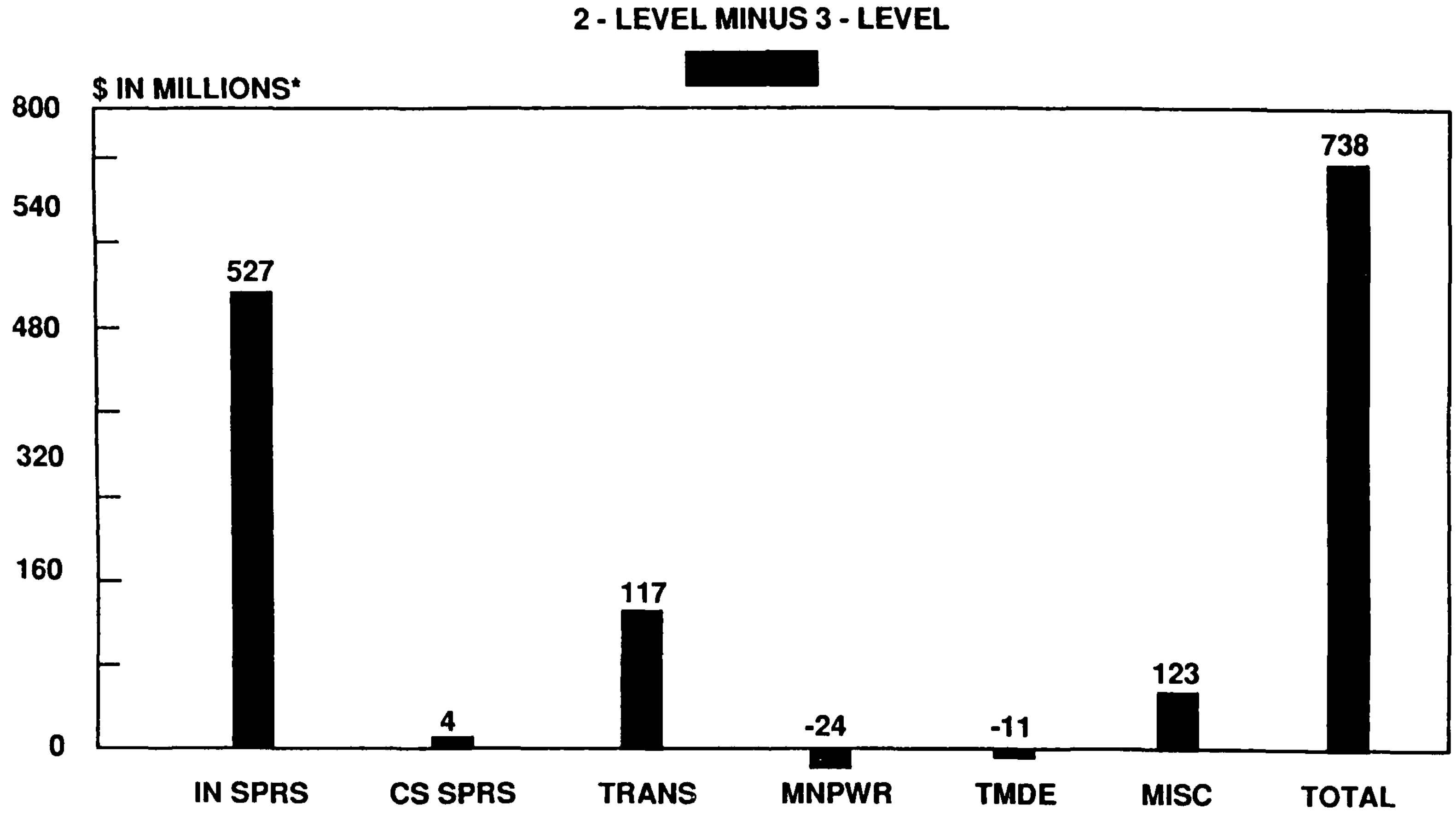
TIU - TRAINING INTERFACE UNIT

FIGURE 11 - MAINTENANCE CONCEPT COST DIFFERENCES BY SUBSYSTEM AT MAX A_o



* SUMMED FOR AIR VEHICLE, LAUNCHER, GROUND CONTROL STATION, MAINTENANCE SHELTER, AIR VEHICLE HANDLER AND TRAINING INTERFACE UNIT.

FIGURE 12 - MAINTENANCE CONCEPT COST DIFFERENCES BY LOGISTICS CATEGORY AT MIN A_o



* SUMMED FOR AIR VEHICLE, LAUNCHER, GROUND CONTROL STATION, MAINTENANCE SHELTER, AIR VEHICLE HANDLER AND TRAINING INTERFACE UNIT.

FIGURE 13 - MAINTENANCE CONCEPT COST DIFFERENCES BY LOGISTICS CATEGORY AT MAX A_o

6.2.3 The striking results from Figures 11 and 13 are that the greatest cost differences are due to initial spares regardless of the A_o each subsystem will obtain.

6.2.4 Table 12 explains the cost differences, shown in Figures 11 and 13, between the two support concepts for each logistic category. This exercise shows that the results obtained are indeed reasonable since they can be explained in terms of specific causes.

TABLE 12. Logistic Category Cost Analysis

COST CATEGORY RESULTS	EXPLANATION
Initial spares (Two Level is more expensive.)	The largest portion of the Two Level Cost is due to subsystem floats. High dollar cost drivers are repaired at Depot with larger turnaround times, and thus require more spares to achieve a given availability
Consumption spares (Two Level is more expensive.)	More items are thrown away under the Two Level Concept instead of being repaired at Depot.
Transportation (Two Level Concept is more expensive.)	Dominant portion of Two Level Concept cost is due to subsystem floats. More repair is accomplished at Depot where larger shipping distances are required.
Manpower (Three Level is more expensive.)	For the Two Level Concept, eventhough more repair is performed at the Depot under higher hourly rates, the Three Level Concept costs for the Contact Team, training and repair dominates.

TABLE 12. - Continued.

COST CATEGORY RESULTS	EXPLANATION
TMDE (Three Level is more expensive.)	When a TPS is required for GS testing, six copies of each specific kind is needed due to the multiplicity of GS sites. For the Two Level Concept, one TPS of each specific kind is needed at Depot. Also, the TMDE cost for the Contact Team contributes about one-half of the total cost. For the Three Level Concept, TMDE cost is easily offset by the savings in spares.
Miscellaneous (Two Level is more expensive.)	The dominant cost is inventory holding which is more expensive due to the abundance of initial spares.

6.3 TEST AND REPAIR MANPOWER HOURS. Figure 14 shows the distribution of test and repair man-hours between the two concepts without considering productivity factors. These hours include Contact Team subsystem repair in the Three Level Concept; and subsystem repair, whenever a float is required, in the Two Level Concept.

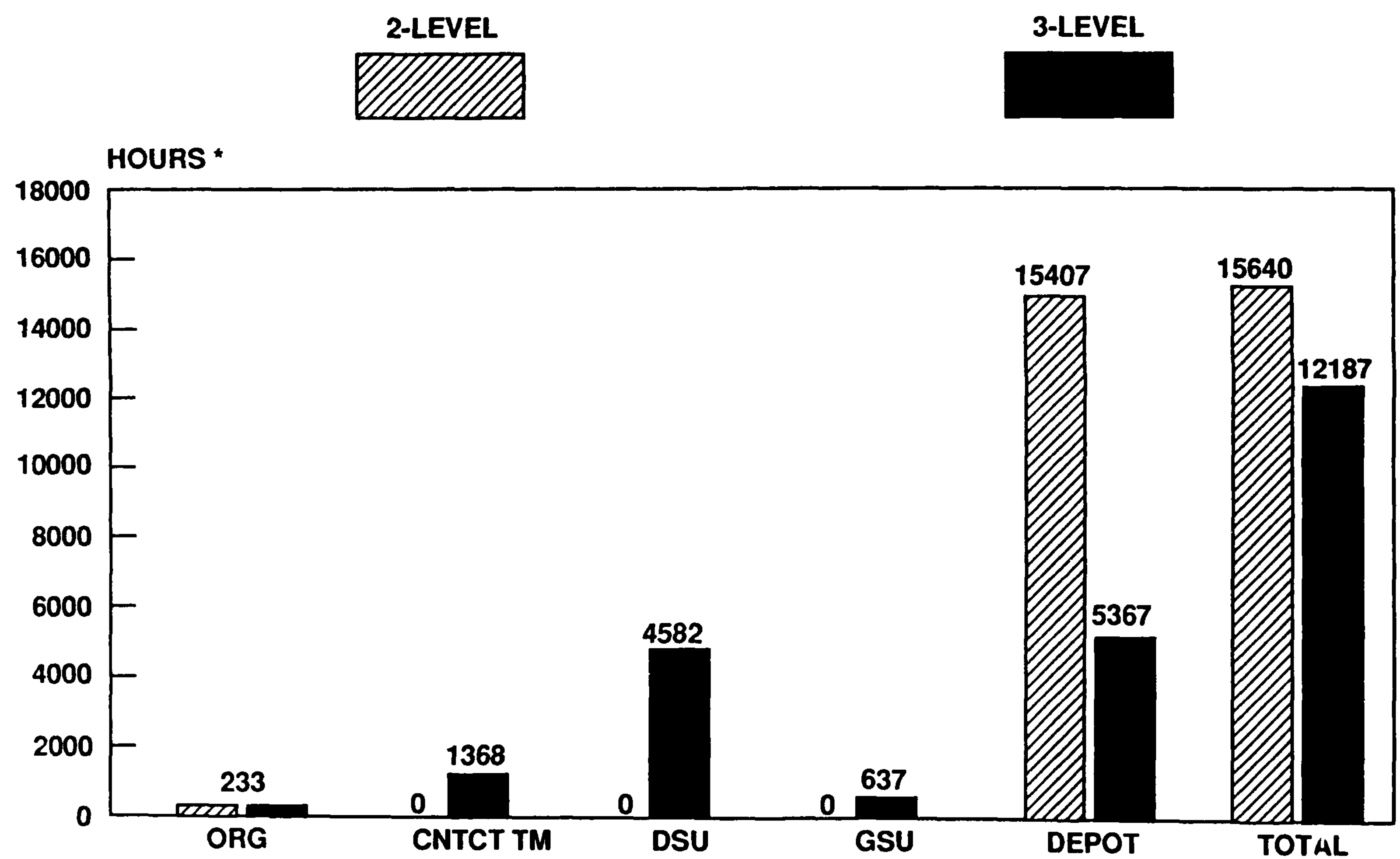
6.3.1 The test and repair man-hours excluding the Contact Team, are "sufficiently close" so that the number of test and repair men required for both concepts should be the same. The facts supporting this conclusion are as follows. Using the data in Figure 14, the total yearly hours required by the Two Level Concept minus the Three Level Concept are:

$$(15640 \text{ hrs} - 12187 \text{ hrs} + 1366 \text{ hrs})/15 \text{ yrs} = 321.3 \text{ hrs/yr}.$$

This amount of hours can easily be absorbed without the need for additional manpower numbers.

6.3.2 It is noted that the high savings in provisioning (See Figures 12 and 13.) for the Three Level Concept is due to Contact Team, DSU and GSU test and repair. This savings is partially reduced by the additional manpower and training cost for the Three Level Concept.

7.0 CAVEATS. Data changes, particularly component (LRU), module and



* SUMMED FOR AIR VEHICLE, LAUNCHER, GROUND CONTROL STATION, MAINTENANCE SHELTER, AIR VEHICLE HANDLER AND TRAINING INTERFACE UNIT.

FIGURE 14 - TEST & REPAIR MANPOWER HOURS BY SUPPORT LEVEL

part costs have modified since they were "fixed" in November [illegible] for this study. Also, failure rates, which account only for operating failures, were used in this study instead of failure factors, which accounts for both operating and nonoperating failures. However, both variables, costs and failures, are subject more to upward revisions than downward. It is speculated that broad upward revisions in costs and failures would tend to make the Three Level Concept even more favorable. The reason being that the Three Level Concept, with more levels of support should be able to adjust to upward revisions in costs and failures with less cost expended than can the Two Level Concept. Preliminary computer runs, not reported in this study, support this speculation.

7.1 Obviously, there may be valid differences of opinion on selected data inputs but the cost differences are so extreme between the Two and Three Level Concepts (See Figures 10 thru 13.) that it is difficult to imagine how any reasonable modification could alter the final conclusions stated in section 9.

8.0 SUGGESTIONS FOR FURTHER STUDY. Once input updates have been accomplished, the below studies would be expedited by using the existing RPV data base developed for this study. The suggested studies are:

a. Modify the Three Level Concept to include additional ORG maintenance skills. It appears that the cost to add certain skills would be more than offset by savings in provisioning costs and improvements in A_o.

b. The OSAMM model could be run to give SESAME provisioning quantities for the seven subsystems addressed in this study. Since SESAME, in a "stand-alone-mode" from OSAMM, would normally be run to develop RPV provisioning, a costly and time consuming process of constructing SESAME inputs would be eliminated.

c. The OSAMM derived MTDs and RTDs could be used to update existing source, maintenance and recoverability (SMR) codes.

d. The OSAMM model, with its minimization routines, could determine a cost effective set of TPS to purchase for each of the seven subsystems addressed in this study.

9.0 CONCLUSIONS. There are three very important reasons to prefer the Three Level Concept when compared to the Two Level Concept. The reasons are:

a. The Three Level Concept is less costly than the Two Level Concept for all of the RPV subsystems studied, except for the air vehicle which only marginally favors the Two Level Concept.

b. The Three Level Concept can achieve a higher theoretical A_o, due to non-reliance on MFs for six of the seven RPV subsystems studied, except for the Training Interface Unit. (The Training Interface Unit does not use MFs in the Two Level Concept.)

c. A_o can be increased with relatively small stockage costs for all seven RPV subsystems studied.

Thus, considering all seven RPV subsystems combined, the Three Level Concept is more cost effective than the Two Level Concept.

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APPENDIX A

CONTACT TEAM COSTS

1.0 BACKGROUND. An RPV Contact Team consists of four military occupational specialties (MOS) as shown in Table 13.

TABLE 13. RPV Contact Team by MOS

MOS	GRADE	QUANTITY
44B	E3	1
63W	E4	1
39C	E5	1
29E	E5	1

SOURCE: TADARS RPV O&O Plan (Ft Sill, OK: US Army Field Artillery School, 1985), p. 5-3

Since each Contact Team is associated with a DSU, there are four Contact Teams in CONUS, four in Europe and one in Korea. Each Contact Team has peculiar support equipment (PSE) which is also accounted for in this Appendix. All costs are in 1987 dollars and discounted by 10% over an assumed fifteen year lifetime. In order to be consistent with study assumptions, constant deployment is assumed for the lifetime. Specific data items used to develop the manpower cost are in Table 14, while data items for vehicle costs are in Table 15. The methodology used in developing contact team Costs, for the most part, is in DA PAM 11-4, Operating Support Cost Guide for Army Materiel Systems (Headquarters, Department of the Army, 1976), pp. 6.1-8.

1.1 TOTAL CONTACT TEAM COST - $34,930,400. The total Contact Team cost consists of the manpower cost, plus the cost of the two truck types, plus the cost of other peculiar support equipment (PSE) costs. Thus, $26,409,650 + $1,644,257 + $447,551 + $6,425,504 = $34,930,400.

2.0 MANPOWER COST - $26,409,650. This cost consists of salaries, theater pay, permanent change of station cost, recruitment, accession and separation cost, training cost, transients, patients and prisoner cost, quarters, maintenance and utilities cost and a medical cost. Manpower cost are estimated in the following sections.

2.1.1 SALARIES - $7,044,177. This cost is obtained from the sum of the salaries for each Contact Team member, times the number of members and times the discount factor. Thus,

($19,823 X 9 + $22,886 X 9 + $27,686 X 18) X 7.98 = $7,044,177.

2.1.2 THEATER PAY - $28,784. This cost is for overseas assignments by theater. It consists of theater pay (except for CONUS), times the number of men per theater, times an inflation factor, times the discount factor and summed by theater. Thus,

($180 X 16 + $130 X 4) X 1.0609 X 7.98 = $28,784.

TABLE 14. Selected Data and Sources for Developing Contact Team Manpower Costs

DATA ITEM	VALUE	SOURCE
Military Personnel Inflation Factor 1985 Base Year	1.0609	[7]
Military Pay Scale		[8]
E3	$19,823	
E4	$22,886	
E5	$27,686	
15 yr, 10% mid year discount factor	7.98	[9]
Hourly wages (2087 hrs/yr)		[8]
E2	$ 8.96	
ORG (E4)	$10.97	
DSU (E5)	$13.27	
GSU (E5)	$13.27	
Overseas Station Allowance Factors		[10]
Europe	$180	
Korea	$130	
PCS		[10]
CONUS	$1400	
CONUS & Europe	$2400	
CONUS & Korea	$1250	
Rotational Travel Rate		[10]
CONUS	1.00	
Europe	.98	
Korea	.50	

TABLE 14 - Continued.

DATA ITEM	VALUE	SOURCE
Recruitments & Accessions	$2350	[10]
Composite Separation Pay Factor	$1450	[10]
Training - Shared Manpower by MOS (no. men; hrs/man/yr)		AMSMI-LC-ME-N
44B	825; 8	
63W	1566; 40	
39C	192; 176	
29E	800; 154	
Annual Loss Rate	.218	[10]
One-Time Training Cost Factor	$8800	[10]
Recurring Training Cost Factor	$2500	[10]
TPP Factor	.0347	[11]
RPMA		[10]
CONUS	$1600	
Europe	$1300	
Korea	$3800	
Medical Factors		[10]
CONUS	$450	
Europe	$350	
Korea	$440	

TABLE 15. Selected Data and Sources for Developing Contact Team Vehicle Costs.

DATA ITEM	VALUE	SOURCE
Operational Maintenance Inflation Factor 1986 Base Year	1.0310	[4]

TABLE 15 - Continued.

DATA ITEM	VALUE	SOURCE
Initial Cost		[12]
Truck M923A2	$580,815	
Truck M1008	$104,103	
Initial POL		[13]
Truck M923A2	78 gal	
Truck M1008	20 gal	
Recurring POL		[13]
Truck M923A2	500 gal	
Truck M1008	369 gal	
POL	$ .75 gal	[13]
Initial Materiel		[13]
Truck M923A2	$2593	
Truck M1008	$ 701	
Recurring Materiel		[13]
Truck M923A2	$7784	
Truck M1008	$ 968	
Annual Maintenance		
Truck M923A2		[13]
ORG	354.0 hrs	
DSU	100.3 hrs	
GSU	83.0 hrs	
Truck M1008		[13]
ORG	168.8 hrs	
DSU	70.81 hrs	
GSU	49.45 hrs	

2.1.3 PERMANENT CHANGE OF STATION (PCS) - $671,623. This cost is from theater PCS cost, tiscount factor. Thus,

($2,350 + $1,450) X .218 X 36 X 1.0609 X 7.98 [illegible] $252,4[illegible].

2.1.5 TRAINING - $17,522,388. This cost does not include RFV instructor and key personnel training which is assumed to be a "wash" in this study. See section 4.7.1 in the main body of this report. It does include training costs for shared manpower receiving peculiar training that is not a "wash" between the Two and Three Level Concepts. (There is a shared MOS at the Unit Level receiving RFV peculiar training for both concepts which is not counted since it is a "wash".) The cost is estimated for each of the four Contact Team MOSs by multiplying the number of hours of training per year, times the number of students, times an assumed hourly salary (E2 grade rate) and times the discount factor. Also, there is a one-time per accession training cost and other recurring training cost. The one-time training cost is estimated from a one-time training cost factor per accession, times a yearly loss rate (accession rate), times number of men, times an inflation factor, times the discount factor. The other recurring training cost is estimated from the recurring training cost factor, times the number of men, times an inflation factor and times the discount factor. Thus,

(8 X 825 + 40 X 1566 + 176 X 192 + 154 X 800) X $ 8.96 X 7.98 +
($8800 X .218 + $2500) X 36 X 1.0609 X 7.98 = $17,522,388.

2.1.6 <u>TRANSIENTS, PATIENTS AND PRISONERS (TPP)</u> - $245,432. This cost is estimated from salaries and theater pay times a TPP factor. Thus,

($7,044,177 + 28,784) X .0347 = $245,432.

2.1.7 <u>QUARTERS, MAINTENANCE AND UTILITIES</u> - $521,504. This cost consists of an average real property maintenance activity (RPMA) cost by theater, times number of men per theater, times an inflation factor, times a discount factor and summed across all theaters. Thus,

($1,600 X 16 + $ 1,300 X 16 + $3,800 X 4) X 1.0609 X 7.98 = $521,504.

2.1.8 <u>MEDICAL SUPPORT</u> - $123,265. This cost consists of an average medical support cost by theater, times the number of men per theater, times an inflation factor and times the discount factor. Thus,

($450 X 16 + $350 X 16 + $440 X 4) X 1.0609 X 7.98 = $123,265.

2.1.9 Totaling the manpower costs gives $10,233,881 for the nine RPV Contact Teams.

2.2 <u>VEHICLE COSTS.</u> The two vehicles which supports the Contact Team are:

a. Truck Cargo: Dropside, 5 ton 6 X 6 w/e M923A2.

b. Truck Cargo: Tactical 5/4 ton 4 X 4 w/e M1008.

The life expectancy of these items exceeds the fifteen year life assumed for RPV in this study. Thus, no replacement costs are required. Vehicle costs consist of the cost of the vehicle, cost of petroleum, oil and lubricants (POL), materiel support and annual maintenance costs.

2.2.1 <u>TRUCK CARGO, M923A2</u> - $1,644,257. The cost for the truck cargo, M923A2 is estimated as follows.

2.2.1.1 INITIAL COST - $582,384. Total initial cost for trucks is the cost of the truck times the number of trucks. Thus,

$64,534 X 9 = $580,815.

2.2.1.2 POL COST - $27,459. Total POL cost is the initial number of POL gallons per truck, times cost per gallon, plus recurring number of POL gallons, times the cost per gallon, times the discount factor and all this times the number of trucks. Thus,

(78 X $ .75 + 500 X $ .75 X 7.98) X 9 = $27,459.

2.2.1.3 MATERIEL SUPPORT COST - $582,384. Total materiel support cost is the sum of the initial materiel cost, plus recurring materiel cost times an inflation factor, times the discount factor and times the number of trucks. Thus,

($2,593 + $7784 X 7.98) X 9 = $582,384.

2.2.1.4 ANNUAL MAINTENANCE COST - $453,599. Total annual maintenance cost is estimated from annual maintenance hours per support level, times the hourly salary charge, summed by support level, times an inflation factor, times the discount factor and times the number of trucks. Thus,

(354 X $10.97 + 100.3 X $13.27 + 83 X $13.27) X 7.98 X 9 = $453,599.

2.2.1.5 Totaling the truck cargo, M923A2, cost gives $1,644,257.

2.2.2 TRUCK CARGO, M1008 - $447,551. The cost for the truck cargo, M1008, is estimated as follows.

2.2.2.1 INITIAL COST - $104,103. The equation for total initial cost is similar to that in section 2.2.1.1. Thus, total initial cost is:

$11,567 X 9 = $104,103.

2.2.2.2 POL COST - $20,011. The equation for POL cost is similar to that in section 2.2.1.2. Thus, total POL cost is:

(20 X $ .75 + 369 X $ .75 X 7.98) X 9 = $20,011.

2.2.2.3 MATERIEL SUPPORT COST - $75,831. The equation for materiel support cost is similar to that in section 2.2.1.3. Thus, total materiel support cost is:

($701 + $968 X 7.98) X 9 = $75,831.

2.2.2.4 ANNUAL MAINTENANCE - $247,606. The equation for annual maintenance cost is similar to that in section 2.2.1.4. Thus, total annual maintenance cost is:

$$(168.8 \times \$10.97 + 70.81 \times \$13.27 + 49.45 \times \$13.27) \times 7.98 \times 9 = \$247,606.$$

2.2.2.5 Totaling the vehicle cost for the truck cargo, M1008, gives $447,551.

2.3 PECULIAR SUPPORT EQUIPMENT (PSE) COST EXCLUDING TRUCKS. Individual PSE items for the Contact Team are not addressed, except for trucks, in this study. However, an independent estimate, which includes the remaining PSE is used.(See [15] and [16].) The estimate does not consider initial spares, miscellaneous and first and second destination transportation costs. Using an engineering judgement of 10% manufacturing cost rather than the usual 20% estimate* for fielded items seems more appropriate for initial spares and miscellaneous. For first and second destination transportation cost an engineering judgement of 1% initial spares cost is used.

2.3.1 PSE COST EXCLUDING TRUCKS - $6,428,942. The PSE cost excluding trucks consists of manufacturing cost in 1987 dollars, plus 3% per year (See [15].) for sustainment, 10% for initial spares and miscellaneous and 1% for first and second destination charges times the number of Contact Teams. Manufacturing cost is given $609,142 per DSU [15].

3.0 LOGISTIC CATEGORIES FOR TOTAL CONTACT TEAM COSTS. The data from this appendix is assembled in Table 16 below by logistic category. It includes sustainment cost for PSE without trucks. Sustainment is "broken down" into consumption spares, transportation and manpower according to an engineering estimate of 45%, 10%, and 45%, respectively. In Appendix B, this total Contact Team Cost($34,930,400) is used to modify the OSAMM outputs.

TABLE 16 - TOTAL CONTACT TEAM COSTS BY LOGISTIC CATEGORY

LOGISTIC CATEGORY	TRUCK M923A2	TRUCK M1008	OTHER PSE	CONTACT TEAM	TOTAL
INIT SPARES	$ 16,336	$ 4,416	$ 335,815		$ 356,567
CONS SPARES	$ 559,047	$ 69,522	$ 516,820		$ 1,145,389
TRANSPORTN	$ 27,459	$ 20,011	$ 118,206		$ 165,676
MANPOWER	$ 453,599	$ 247,606	$ 516,820	$26,409,650	$27,627,675

TABLE 16 - Continued.

TMDE (INIT. COST)	$ 580,815	$ 104,103	$4,797,360	-	$ 5,482,278
MISC*	$ 7,001	$ 1,893	$ 143,921	-	$ 152,815
TOTAL	$1,644,257	$ 447,551	$6,428,942	$26,409,650	$34,930,400

APPENDIX B

PROVISIONING LINE UPDATE COSTS

1.0 BACKGROUND. If a Two Level Maintenance Concept is imposed, there will be about a 45%* change to existing provisioning files. Logistics Support Analysis (LSA) "C" and "D" sheets will be modified. The following is an estimate of the cost to perform this update.

2.0 ESTIMATING METHOD. The formula for estimating the provisioning update cost (PUC) is:

$$PUC = A \times B \times C$$

where A is the number of "C" plus "D" sheets to be modified; B is the contractor/Government man-hours per sheet; C is the contractor/Government charge per man-hour. Table 17 gives the contractor and Government charges used in the above equation.

TABLE 17. Contractor/Government Charges

	MAN-HOURS	HOURLY RATES
Contractor	.5	$60.00
Government	.17	$25.58
Source: MLC. Maint Engineering Dir.		

Table 18 displays the update cost. These costs are used in Appendix C to modify the Two Level Concept cost from OSAMM. They are included in the initial spares category.

TABLE 18. Provisioning Line Update Costs

SUBSYSTEM	C&D SHEETS*	PUC CONTRACTOR	PUC GOVERNMENT	TOTAL PUC
Air Vehicle	1,617	$ 48,510	$ 7,032	$ 55,542
Launcher	1,433	$ 42,990	$ 6,232	$ 49,222
Recovery	1,294	$ 38,820	$ 5,627	$ 44,447
Ground Control Station	3,466	$103,980	$ 15,072	$119,052
Maintenance Shelter	1,294	$ 38,820	$ 5,627	$ 44,447
Air Vehicle Handler	462	$ 13,860	$ 2,009	$ 15,869

*Source: MLC, Manit. Engineering Dir., MICOM.

TABLE 18. - Continued.

SUBSYSTEM	C&D SHEETS*	PUC CONTRACTOR	PUC GOVERNMENT	TOTAL PUC
Training Interface Unit	92	$ 2,760	$ 400	$ 3,160

*Source: RPV Provisio ing Review, July 1986.

APPENDIX C

S&M COST CURVE DATA

1.0 <u>OSAMM OUTPUTS</u>. Table 19 gives the numerical outputs from OSAMM used to construct Figures 3 through 9 in the main body of this report. The Two Level Concept costs are modified to include the PUC from Appendix B. Also, the Three Level Concept costs are modified to include the subsystem portion of the prorated Contact Team cost. Table 20 gives the prorated Contact Team costs along with the failures per year, and the fraction of failures used to construct the prorated costs.

TABLE 19. S&M Cost Curve Data by Subsystem

SUBSYSTEM	2-LEVEL CONCEPT		3-LEVEL CONCEPT	
	Ao	Cost*	Ao	Cost†
Air Vehicle	.9430	10.47	.8935	10.72
	.9609	10.49	.9280	10.73
	.9840	12.65	.9693	11.5[illegible]
			.9918	14.42
Launcher	.6251	12.13	.7730	3.35
	.7033	12.37	.8730	3.75
	.8038	13.37	.9370	4.06
	.9684	22.62	.9884	4.30
	.9940	33.77	.9911	4.36
Recovery	.5478	21.56	.8530	5.32
	.6600	21.66	.9127	5.40
	.7190	21.70	.9632	5.46
	.9749	35.40	.9964	6.10
	.9983	50.03		
Ground Control Station	.2014	286.57	.8148	53.50
	.3706	288.60	.8174	53.51
	.6180	320.65	.8642	53.70
	.8038	376.53	.9178	54.48
	.9201	501.67	.9924	61.24
Maintenance Shelter	.3273	152.10	.3560	21.95
	.5153	163.63	.6067	22.41
	.6626	173.89	.9361	24.00
	.9259	223.98	.9490	24.13
			.9612	24.31

TABLE 19 - Continued.

SUBSYSTEM	2-LEVEL CONCEPT		3-LEVEL CONCEPT	
			.9915	25.82
Air Vehicle Handler	.7062	3.32	.8422	1.37
	.8233	3.41	.8720	1.38
	.9976	7.04	.9133	1.42
			.9708	1.46
			.9775	1.48
			.9944	1.58
Training Interface Unit	.1008	9.32	.1449	3.10
	.4837	10.08	.5771	3.44
	.9750	18.25	.7029	3.60
	.9962	26.19	.8230	3.81
			.9349	3.[illegible]
			.9901	4.26

*Cost in Millions

TABLE 20. Prorated Contact Team Costs

SUBSYSTEM	PRORATED COST*	CONTACT TEAM WORLD-WIDE FAILURES	FRACTION OF TOTAL FAILURES
Air Vehicle	$ 415,078	15.85	.011[illegible]
Launcher	$ 1,172,229	45.90	.033559
Recovery	$ 86,592	3.39	.002479
Ground Control Station	$23,795,881	931.77	.68123
Maintenance Shelter	$ 9,469,352	370.79	.271092
Air Vehicle Handler	$ 1,537	.06	.000044
Training Interface Unit	$ 0	0.00	0.000000
TOTAL	$34,930,400	1,367.76	1.000000

*Cost is in dollars

APPENDIX D

ACRONYMS

MC	Army Materiel Command
AMCPM-RP	Remote Piloted Vehicle Project Office
AMSAA-IRO	US Army Materiel Systems Analysis Activity - Inventory Research Office
AMSMI-LC-ME	Maintenance Engineering Directorate
AMSMI-LC-TA	Technical Analysis and Support Office
AMSMI-OR-SA	Systems Analysis Division
A_o	Operational Availability
CECOM	US Army Communications-Electronics Command
CONUS	Continental United States
da	Days
DS	Direct Support
DSU	Direct Support Unit
gal	Gallons
GS	General Support
GSU	General Support Unit
HQ AMC	Headquarters, Army Materiel Command
hrs	Hours
IFTE	Intermediate Forward Test Equipment
LCCA	Life-Cycle Cost Analysis
LOGAM	Logistic Analysis Model
LRU	Line-Replaceable Unit
MAX Ao	Maximum Ao
MCTBF	Mean Calendar Time Between Failure
MF	Maintenance Float
mi	Miles
MICOM	United States Army Missile Command
MIN Ao	Minimum Ao
MLC	Missile Logistics Center
MLDT	Mean Logistic Down Time
MOS	Military Occupational Speciality
MTBF	Mean Time Between Failure
MTD	Maintenance Task Distribution
MTR	Mean Time to Repair
MTRF	Mean Time to Repair a subsystem, adjusted for MF Order and Ship Times
MTT	Mean Transportation Time
O&S	Operation and Support
ORG	Organizational
OSAMM	Optimum Supply and Maintenance Model
POL	Petroleum, Oil and Lubricants
PSE	Peculiar Support Equipment
RPMA	Real Property Maintenance Activity

ACRONYMS

RPSTL	Repair Parts and Special Tools
RPV	Remotely Piloted Vehicle
RTD	Replacement Task Distribution
S&M	Supply and Maintenance
SESAME	Selected Essential-Item Stockage for Availability Method
SIP	Standard Initial Provisioning
SMR	Source, Maintenance, Recoverability Code
TASC	The Analytical Sciences Corporation
TPP	Transients, Patients and Prisoners

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